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(54) Title: IL-8 RECEPTOR ANTAGONISTS

(57) Abstract: This invention relates to novel compounds of Formula (I), and pharmaceutical compositions thereof, and methods of treatment of disease states mediated by the chemokine, Interleukin-8 (IL-8).

IL-8 RECEPTOR ANTAGONISTS

FIELD OF THE INVENTION

This invention relates to novel benzo-2-triazole substituted compounds, pharmaceutical compositions, processes for their preparation, and use thereof in treating IL-8, GRO α , GRO β , GRO γ and NAP-2 mediated diseases.

BACKGROUND OF THE INVENTION

Many different names have been applied to Interleukin-8 (IL-8), such as neutrophil attractant/activation protein-1 (NAP-1), monocyte derived neutrophil chemotactic factor (MDNCF), neutrophil activating factor (NAF), and T-cell lymphocyte chemotactic factor. 10 Interleukin-8 is a chemoattractant for neutrophils, basophils, and a subset of T-cells. It is produced by a majority of nucleated cells including macrophages, fibroblasts, endothelial and epithelial cells exposed to TNF, IL-1 α , IL-1 β or LPS, and by neutrophils themselves when exposed to LPS or chemotactic factors such as FMLP. M. Baggolini et al., *J. Clin. Invest.* 84, 15 1045 (1989); J. Schroder et al., *J. Immunol.* 139, 3474 (1987) and *J. Immunol.* 144, 2223 (1990); Strieter, et al., *Science* 243, 1467 (1989) and *J. Biol. Chem.* 264, 10621 (1989); Cassatella et al., *J. Immunol.* 148, 3216 (1992).

GRO α , GRO β , GRO γ and NAP-2 also belong to the chemokine a family. Like IL-8 these chemokines have also been referred to by different names. For instance GRO α , β , γ have 20 been referred to as MGSAa, b and g respectively (Melanoma Growth Stimulating Activity), see Richmond et al., *J. Cell Physiology* 129, 375 (1986) and Chang et al., *J. Immunol.* 148, 451 (1992). All of the chemokines of the a-family which possess the ELR motif directly preceding the CXC motif bind to the IL-8 B receptor.

IL-8, GRO α , GRO β , GRO γ , NAP-2, and ENA-78 stimulate a number of functions in 25 vitro. They have all been shown to have chemoattractant properties for neutrophils, while IL-8 and GRO α have demonstrated T-lymphocytes, and basophiles chemotactic activity. In addition IL-8 can induce histamine release from basophils from both normal and atopic individuals GRO- α and IL-8 can in addition, induce lysozomal enzyme release and respiratory burst from neutrophils. IL-8 has also been shown to increase the surface expression of Mac-1 30 (CD11b/CD18) on neutrophils without de novo protein synthesis. This may contribute to increased adhesion of the neutrophils to vascular endothelial cells. Many known diseases are characterized by massive neutrophil infiltration. As IL-8, GRO α , GRO β , GRO γ and NAP-2 promote the accumulation and activation of neutrophils, these chemokines have been 35 implicated in a wide range of acute and chronic inflammatory disorders including psoriasis and rheumatoid arthritis, Baggolini et al., *FEBS Lett.* 307, 97 (1992); Miller et al., *Crit. Rev. Immunol.* 12, 17 (1992); Oppenheim et al., *Annu. Rev. Immunol.* 9, 617 (1991); Seitz et al., *J. Clin. Invest.* 87, 463 (1991); Miller et al., *Am. Rev. Respir. Dis.* 146, 427 (1992); Donnelly et al., *Lancet* 341, 643 (1993). In addition the ELR chemokines (those containing the amino

acids ELR motif just prior to the CXC motif) have also been implicated in angiostasis. Strieter et al., *Science* 258, 1798 (1992).

In vitro, IL-8, and NAP-2 induce neutrophil shape change, chemotaxis, granule release, and respiratory burst, by binding to and activating receptors of the seven-transmembrane, G-protein-linked family, in particular by binding to IL-8 receptors, most notably the B-receptor. Thomas et al., *J. Biol. Chem.* 266, 14839 (1991); and Holmes et al., *Science* 253, 1278 (1991). The development of non-peptide small molecule antagonists for members of this receptor family has precedent. For a review see R. Freidinger in: *Progress in Drug Research*, Vol. 40, pp. 33-98, Birkhauser Verlag, Basel 1993. Hence, the IL-8 receptor represents a promising target for the development of novel anti-inflammatory agents.

Two high affinity human IL-8 receptors (77% homology) have been characterized: IL-8Ra, which binds only IL-8 with high affinity, and IL-8Rb, which has high affinity for IL-8 as well as for GRO α , GRO β , GRO γ and NAP-2. See Holmes et al., supra; Murphy et al., *Science* 253, 1280 (1991); Lee et al., *J. Biol. Chem.* 267, 16283 (1992); LaRosa et al., *J. Biol. Chem.* 267, 25402 (1992); and Gayle et al., *J. Biol. Chem.* 268, 7283 (1993).

There remains a need for treatment, in this field, for compounds which are capable of binding to the IL-8 a or b receptor. Therefore, conditions associated with an increase in IL-8 production (which is responsible for chemotaxis of neutrophil and T-cells subsets into the inflammatory site) would benefit by compounds which are inhibitors of IL-8 receptor binding.

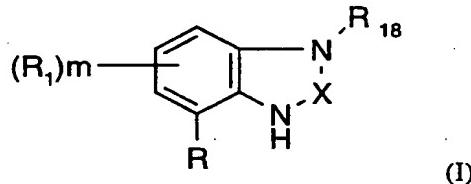
SUMMARY OF THE INVENTION

This invention provides for a method of treating a chemokine mediated disease, wherein the chemokine is one which binds to an IL-8 α or β receptor and which method comprises administering an effective amount of a compound of Formula (I) or (II) or a pharmaceutically acceptable salt thereof. In particular the chemokine is IL-8.

This invention also relates to a method of inhibiting the binding of IL-8 to its receptors in a mammal in need thereof which comprises administering to said mammal an effective amount of a compound of Formula (I) or (II).

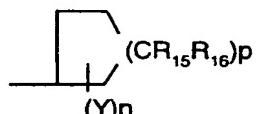
The present invention also provides for the novel compounds of Formula (I), and (II) and pharmaceutical compositions comprising a compound of Formula (I), and (II) and a pharmaceutical carrier or diluent.

Compounds of Formula (I) useful in the present invention are represented by the structure:



wherein

R is -NH-C(X₂)-NH-(CR₁₃R₁₄)_v-Z;



Z is W, HET, (Y)n, an optionally substituted C₁₋₁₀ alkyl, an optionally substituted C₂₋₁₀ alkenyl, or an optionally substituted C₂₋₁₀ alkynyl;

X is C(X₁)₂, C(O), C(S), S(O)₂, PO(OR₄), or C=N-R₁₉;

X₁ is independently hydrogen, halogen, C₁₋₁₀ alkyl, NR₄R₅, C₁₋₁₀ alkyl-NR₄R₅,

5 C(O)NR₄R₅, optionally substituted C₁₋₁₀ alkyl, C₁₋₁₀ alkoxy, halosubstituted C₁₋₁₀ alkoxy, hydroxy, aryl, aryl C₁₋₄ alkyl, aryloxy, aryl C₁₋₄ alkyloxy, heteroaryl, heteroarylalkyl, heterocyclic, heterocyclic C₁₋₄alkyl, or heteroaryl C₁₋₄ alkyloxy;

X₂ is =O, or =S;

R₁ is independently selected from hydrogen; halogen; nitro; cyano; halosubstituted C₁₋₁₀ alkyl; C₁₋₁₀ alkyl; C₂₋₁₀ alkenyl; C₁₋₁₀ alkoxy; halosubstituted C₁₋₁₀ alkoxy; azide; (CR₈R₈)q S(O)_tR₄, hydroxy; hydroxy C₁₋₄alkyl; aryl; aryl C₁₋₄ alkyl; aryloxy; aryl C₁₋₄ alkyloxy; heteroaryl; heteroarylalkyl; heterocyclic, heterocyclic C₁₋₄alkyl; heteroaryl C₁₋₄ alkyloxy; aryl C₂₋₁₀ alkenyl; heteroaryl C₂₋₁₀ alkenyl; heterocyclic C₂₋₁₀ alkenyl; (CR₈R₈)qNR₄R₅; C₂₋₁₀ alkenyl C(O)NR₄R₅; (CR₈R₈)q C(O)NR₄R₅; (CR₈R₈)q

10 C(O)NR₄R₁₀; S(O)₃R₈; (CR₈R₈)q C(O)R₁₁; C₂₋₁₀ alkenyl C(O)R₁₁; C₂₋₁₀ alkenyl C(O)OR₁₁; C(O)R₁₁; (CR₈R₈)q C(O)OR₁₂; (CR₈R₈)q OC(O) R₁₁; (CR₈R₈)q

15 NR₄C(O)R₁₁; (CR₈R₈)qC(NR₄)NR₄R₅; (CR₈R₈)q NR₄C(NR₅)R₁₁; (CR₈R₈)q NHS(O)₂R₁₇; or (CR₈R₈)q S(O)₂NR₄R₅; or two R₁ moieties together may form O-(CH₂)_sO or a 5 to 6 membered saturated or unsaturated ring; and wherein the aryl,

20 heteroaryl, and heterocyclic containing moieties may all be optionally substituted;

n is an integer having a value of 1 to 3;

m is an integer having a value of 1 to 3;

q is 0, or an integer having a value of 1 to 10;

s is an integer having a value of 1 to 3;

25 t is 0, or an integer having a value of 1 or 2;

v is 0, or an integer having a value of 1 to 4;

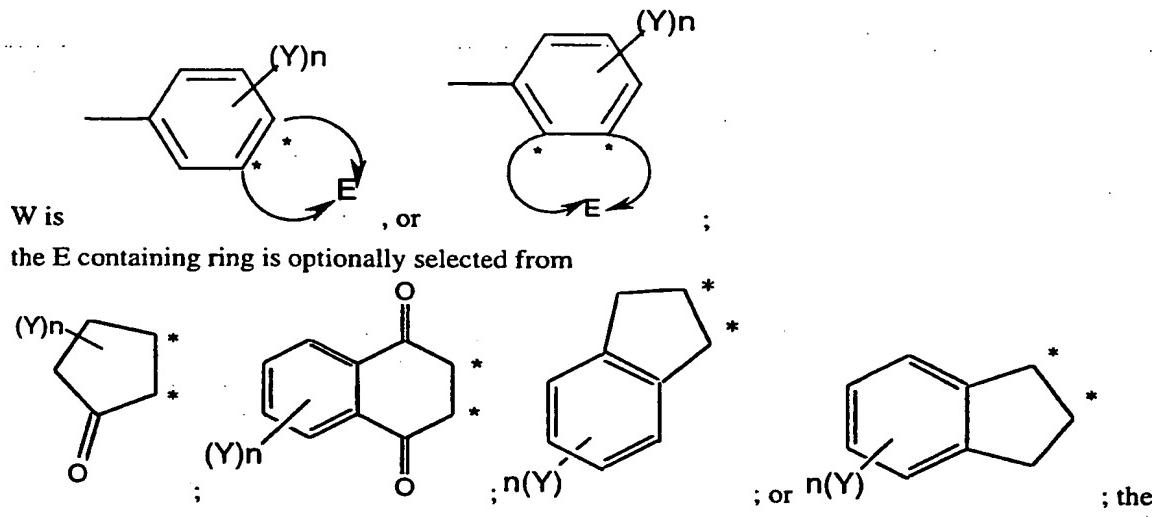
p is an integer having a value of 1 to 3;

HET is an optionally substituted heteroaryl;

R₄ and R₅ are independently hydrogen, optionally substituted C₁₋₄ alkyl, optionally substituted aryl, optionally substituted aryl C₁₋₄alkyl, optionally substituted heteroaryl, optionally substituted heteroaryl C₁₋₄alkyl, heterocyclic, or heterocyclic C₁₋₄ alkyl, or R₄ and R₅ together with the nitrogen to which they are attached form a 5 to 7 member ring which may optionally comprise an additional heteroatom selected from O/N/S;

30 Y is independently selected from hydrogen; halogen; nitro; cyano; halosubstituted C₁₋₁₀ alkyl; C₁₋₁₀ alkyl; C₂₋₁₀ alkenyl; C₁₋₁₀ alkoxy; halosubstituted C₁₋₁₀ alkoxy; azide; (CR₈R₈)q S(O)_tR₄; hydroxy; hydroxyC₁₋₄alkyl; aryl; aryl C₁₋₄ alkyl; aryloxy; arylC₁₋₄

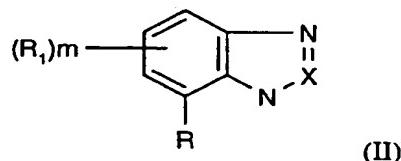
- alkyloxy; heteroaryl; heteroarylalkyl; heteroaryl C₁-4 alkyloxy; heterocyclic, heterocyclic C₁-4alkyl; aryl C₂-10 alkenyl; heteroaryl C₂-10 alkenyl; heterocyclic C₂-10 alkenyl; (CR₈R₈)q NR₄R₅; C₂-10 alkenyl C(O)NR₄R₅; (CR₈R₈)q C(O)NR₄R₅; (CR₈R₈)q C(O)NR₄R₁₀; S(O)₃R₈; (CR₈R₈)q C(O)R₁₁; C₂-10 alkenyl C(O)R₁₁; C₂-10 alkenyl C(O)OR₁₁; (CR₈R₈)q C(O)OR₁₂; (CR₈R₈)q OC(O) R₁₁; (CR₈R₈)q NR₄C(O)R₁₁; (CR₈R₈)qC(NR₄)NR₄R₅; (CR₈R₈)q NR₄C(NR₅)R₁₁; (CR₈R₈)q NHS(O)₂R_a; or (CR₈R₈)q S(O)₂NR₄R₅; or two Y moieties together may form O-(CH₂)₅O or a 5 to 6 membered saturated or unsaturated ring; and wherein the aryl, heteroaryl, and heterocyclic containing moieties may all be optionally substituted;
- 5 R₆ and R₇ are independently hydrogen or a C₁-4 alkyl group, or R₆ and R₇ together with the nitrogen to which they are attached form a 5 to 7 member ring which ring may optionally contain an additional heteroatom which heteroatom is selected from oxygen, nitrogen or sulfur;
- 10 R₈ is independently hydrogen or C₁-4 alkyl;
- 15 R₁₀ is C₁-10 alkyl C(O)₂R₈;
- R₁₁ is hydrogen, C₁-4 alkyl, optionally substituted aryl, optionally substituted aryl C₁-4alkyl, optionally substituted heteroaryl, optionally substituted heteroarylC₁-4alkyl, optionally substituted heterocyclic, or optionally substituted heterocyclicC₁-4alkyl;
- 20 R₁₂ is hydrogen, C₁-10 alkyl, optionally substituted aryl or optionally substituted arylalkyl;
- 25 R₁₃ and R₁₄ are independently hydrogen, or optionally substituted C₁-4 alkyl, or one of R₁₃ and R₁₄ may be optionally substituted aryl;
- R₁₅ and R₁₆ are independently hydrogen, or an optionally substituted C₁-4 alkyl;
- R₁₇ is C₁-4alkyl, aryl, arylalkyl, heteroaryl, heteroarylC₁-4alkyl, heterocyclic, or heterocyclicC₁-4alkyl, wherein the aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted;
- 30 R₁₈ is hydrogen, optionally substituted C₁-10 alkyl, C₁-10 alkoxy, halosubstituted C₁-10 alkoxy, hydroxy, arylC₁-4 alkyl, arylC₂-4 alkenyl, heteroaryl, heteroaryl-C₁-4alkyl, heteroarylC₂-4 alkenyl, heterocyclic, or heterocyclicC₁-4 alkyl, wherein the aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted;
- 35 R₁₉ is cyano, nitro, S(O)₂NR₄R₅, S(O)₂R₁₇, alkyl, arylC₁-4 alkyl, arylC₂-4 alkenyl, heteroaryl, heteroaryl-C₁-4alkyl, heteroarylC₂-4 alkenyl, heterocyclic, or heterocyclicC₁-4 alkyl; and wherein the alkyl, aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted;
- R_a is NR₆R₇, alkyl, arylC₁-4 alkyl, arylC₂-4 alkenyl, heteroaryl, heteroaryl-C₁-4alkyl, heteroarylC₂-4 alkenyl, heterocyclic, or heterocyclicC₁-4 alkyl; and wherein the aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted;



asterix * denoting point of attachment of the ring;

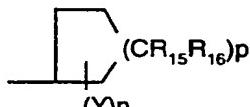
- 5 or a pharmaceutically acceptable salt thereof.

Compounds of Formula (II) useful in the present invention are represented by the structure:



- 10 wherein

R is -NH-C(X2)-NH-(CR₁₃R₁₄)_v-Z;



Z is W, HET, (Y)n , optionally substituted C₁₋₁₀ alkyl, optionally substituted C₂₋₁₀ alkenyl, or optionally substituted C₂₋₁₀ alkynyl;

- 15 X is N, or C(X₁);

X₁ is hydrogen, halogen, C₁₋₁₀ alkyl, NR₄R₅, C₁₋₁₀ alkyl-NR₄R₅, C(O)NR₄R₅, C₁₋₁₀ alkylC(O)NR₄R₅, optionally substituted C₁₋₁₀ alkyl, C₁₋₁₀ alkoxy, halosubstituted C₁₋₁₀ alkoxy, hydroxy, aryl, aryl C₁₋₄ alkyl, aryloxy; aryl C₁₋₄ alkyloxy, heteroaryl, heteroarylalkyl, heterocyclic, heterocyclic C₁₋₄alkyl, or heteroaryl C₁₋₄ alkyloxy;

- 20 X₂ is =O, or =S;

R₁ is independently selected from hydrogen; halogen; nitro; cyano; halosubstituted C₁₋₁₀ alkyl; C₁₋₁₀ alkyl; C₂₋₁₀ alkenyl; C₁₋₁₀ alkoxy; halosubstituted C₁₋₁₀ alkoxy; azide; (CR₈R₈)_qS(O)₁R₄, hydroxy; hydroxy C₁₋₄alkyl; aryl; aryl C₁₋₄ alkyl; aryloxy; aryl C₁₋₄ alkyloxy; heteroaryl; heteroarylalkyl; heterocyclic, heterocyclic C₁₋₄alkyl; heteroaryl C₁₋₄

alkyloxy; aryl C₂-10 alkenyl; heteroaryl C₂-10 alkenyl; heterocyclic C₂-10 alkenyl;
(CR₈R₈)qNR₄R₅; C₂-10 alkenyl C(O)NR₄R₅; (CR₈R₈)q C(O)NR₄R₅; (CR₈R₈)q
C(O)NR₄R₁₀; S(O)₃R₈; (CR₈R₈)q C(O)R₁₁; C₂-10 alkenyl C(O)R₁₁; C₂-10 alkenyl
C(O)OR₁₁; C(O)R₁₁; (CR₈R₈)q C(O)OR₁₂; (CR₈R₈)q OC(O) R₁₁;
5 (CR₈R₈)qNR₄C(O)R₁₁; (CR₈R₈)qC(NR₄)NR₄R₅; (CR₈R₈)q NR₄C(NR₅)R₁₁;
(CR₈R₈)q NHS(O)₂R₁₇; (CR₈R₈)q S(O)₂NR₄R₅; or two R₁ moieties together may form
O-(CH₂)_s-O or a 5 to 6 membered saturated or unsaturated ring; and wherein the aryl,
heteroaryl, and heterocyclic containing moieties may all be optionally substituted;
n is an integer having a value of 1 to 3;
10 m is an integer having a value of 1 to 3;
q is 0, or an integer having a value of 1 to 10;
t is 0, or an integer having a value of 1 or 2;
s is an integer having a value of 1 to 3;
v is 0, or an integer having a value of 1 to 4;
15 p is an integer having a value of 1 to 3;
HET is an optionally substituted heteroaryl;
R₄ and R₅ are independently hydrogen, optionally substituted C₁-4 alkyl, optionally
substituted aryl, optionally substituted aryl C₁-4alkyl, optionally substituted heteroaryl,
optionally substituted heteroaryl C₁-4alkyl, heterocyclic, heterocyclic C₁-4 alkyl, or R₄
20 and R₅ together with the nitrogen to which they are attached form a 5 to 7 member ring
which may optionally comprise an additional heteroatom selected from O/N/S;
Y is independently selected from hydrogen; halogen; nitro; cyano; halosubstituted C₁-10 alkyl;
C₁-10 alkyl; C₂-10 alkenyl; C₁-10 alkoxy; halosubstituted C₁-10 alkoxy; azide;
(CR₈R₈)q S(O)_tR₄; hydroxy; hydroxyC₁-4alkyl; aryl; aryl C₁-4 alkyl; aryloxy; arylC₁-4
25 alkyloxy; heteroaryl; heteroarylalkyl; heteroaryl C₁-4 alkyloxy; heterocyclic, heterocyclic
C₁-4alkyl; aryl C₂-10 alkenyl; heteroaryl C₂-10 alkenyl; heterocyclic C₂-10 alkenyl;
(CR₈R₈)q NR₄R₅; C₂-10 alkenyl C(O)NR₄R₅; (CR₈R₈)q C(O)NR₄R₅; (CR₈R₈)q
C(O)NR₄R₁₀; S(O)₃R₈; (CR₈R₈)q C(O)R₁₁; C₂-10 alkenyl C(O)R₁₁; C₂-10 alkenyl
C(O)OR₁₁; (CR₈R₈)q C(O)OR₁₂; (CR₈R₈)q OC(O) R₁₁; (CR₈R₈)qC(NR₄)NR₄R₅;
30 (CR₈R₈)q NR₄C(NR₅)R₁₁; (CR₈R₈)q NR₄C(O)R₁₁; (CR₈R₈)q NHS(O)₂R_a; (CR₈R₈)q
S(O)₂NR₄R₅; or two Y moieties together may form O-(CH₂)_s-O or a 5 to 6 membered
saturated or unsaturated ring; and wherein the aryl, heteroaryl, and heterocyclic containing
moieties may all be optionally substituted;
R₆ and R₇ are independently hydrogen or a C₁-4 alkyl group, or R₆ and R₇ together with the
35 nitrogen to which they are attached form a 5 to 7 member ring which ring may optionally
contain an additional heteroatom which heteroatom is selected from oxygen, nitrogen or
sulfur;
R₈ is independently hydrogen or C₁-4 alkyl;
R₁₀ is C₁-10 alkyl C(O)₂R₈;

R₁₁ is hydrogen, C₁₋₄ alkyl, optionally substituted aryl, optionally substituted aryl C₁₋₄alkyl, optionally substituted heteroaryl, optionally substituted heteroarylC₁₋₄alkyl, optionally substituted heterocyclic, or optionally substituted heterocyclicC₁₋₄alkyl;

R₁₂ is hydrogen, C₁₋₁₀ alkyl, optionally substituted aryl or optionally substituted arylalkyl;

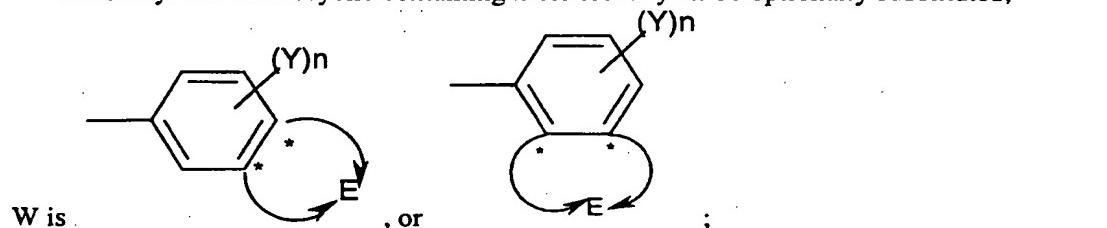
5 R₁₃ and R₁₄ are independently hydrogen, or optionally substituted C₁₋₄ alkyl, or one of R₁₃ and R₁₄ may be optionally substituted aryl;

R₁₅ and R₁₆ are independently hydrogen, or an optionally substituted C₁₋₄ alkyl;

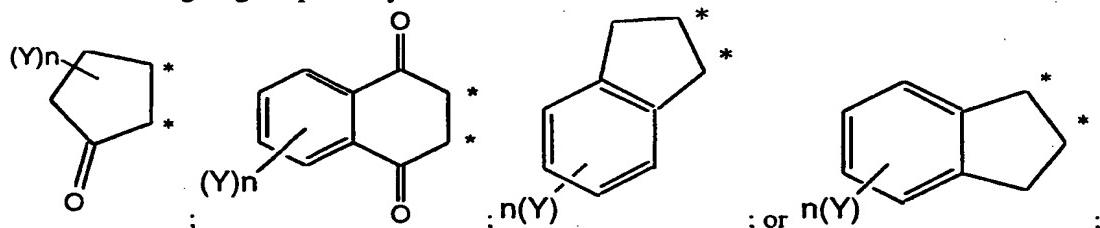
10 R₁₇ is C₁₋₄alkyl, aryl, arylalkyl, heteroaryl, heteroarylC₁₋₄alkyl, heterocyclic, or heterocyclicC₁₋₄alkyl; and wherein the aryl, heteroaryl and heterocyclic containing

moieties may all be optionally substituted;

15 R_a is NR₆R₇, alkyl, arylC₁₋₄ alkyl, arylC₂₋₄ alkenyl, heteroaryl, heteroaryl-C₁₋₄alkyl, heteroarylC₂₋₄ alkenyl, heterocyclic, or heterocyclicC₁₋₄ alkyl; and wherein the aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted;



15 the E containing ring is optionally selected from



the asterix * denoting point of attachment of the ring;
or a pharmaceutically acceptable salt thereof.

DETAILED DESCRIPTION OF THE INVENTION

20 The compounds of Formula (I) and (II) may also be used in association with the veterinary treatment of mammals, other than humans, in need of inhibition of IL-8 or other chemokines which bind to the IL-8 a and b receptors. Chemokine mediated diseases for treatment, therapeutically or prophylactically, in animals include disease states such as those noted herein in the Methods of Treatment section.

25 As readily seen, the difference between compounds of Formula (I) and (II) lies in the unsaturation of the A containing ring, and hence the substitutions on the X moiety. The remaining terms, defined below, are the same for both compounds of Formula (I) and (II) unless otherwise indicated.

In compounds of Formula (I), suitably R₁ is independently selected from hydrogen; halogen; nitro; cyano; halosubstituted C₁₋₁₀ alkyl, such as CF₃; C₁₋₁₀ alkyl, such as methyl,

ethyl, isopropyl, or n-propyl; C₂-10 alkenyl; C₁-10 alkoxy, such as methoxy, or ethoxy; halosubstituted C₁-10 alkoxy, such as trifluoromethoxy; azide; (CR₈R₈)_qS(O)_tR₄, wherein t is 0, 1 or 2; hydroxy; hydroxy C₁-4alkyl, such as methanol or ethanol; aryl, such as phenyl or naphthyl; aryl C₁-4 alkyl, such as benzyl; aryloxy, such as phenoxy; aryl C₁-4 alkyloxy, such as benzyloxy; heteroaryl; heteroarylalkyl; heteroaryl C₁-4 alkyloxy; aryl C₂-10 alkenyl; heteroaryl C₂-10 alkenyl; heterocyclic C₂-10 alkenyl; (CR₈R₈)_qNR₄R₅; C₂-10 alkenyl C(O)NR₄R₅; (CR₈R₈)_qC(O)NR₄R₅; (CR₈R₈)_qC(O)NR₄R₁₀; S(O)₃H; S(O)₃R₈; (CR₈R₈)_qC(O)R₁₁; C₂-10 alkenyl C(O)R₁₁; C₂-10 alkenyl C(O)OR₁₁; C(O)R₁₁; (CR₈R₈)_qC(O)OR₁₂; (CR₈R₈)_qOCC(O)R₁₁; (CR₈R₈)_qNR₄C(O)R₁₁; (CR₈R₈)_qC(NR₄)NR₄R₅; (CR₈R₈)_qNR₄C(NR₅)R₁₁; (CR₈R₈)_qNHS(O)₂R₁₇; (CR₈R₈)_qS(O)₂NR₄R₅; or two R₁ moieties together may form O-(CH₂)_s-O or a 5 to 6 membered saturated or unsaturated ring. All of the aryl, heteroaryl, and heterocyclic containing moieties may be optionally substituted as defined herein below.

Preferably, R₁ is hydrogen, halogen, cyano, nitro, CF₃, (CR₈R₈)_qC(O)NR₄R₅, C₂-10 alkenyl C(O)NR₄R₅, (CR₈R₈)_qC(O)R₄R₁₀, C₂-10 alkenyl C(O)OR₁₂, heteroaryl, heteroaryl C₁-4 alkyl, heteroaryl C₂-10 alkenyl, or S(O)₂NR₄R₅. More preferably, R₁ is halogen, cyano, or nitro. For compounds of Formula (I) and (II), R₁ is preferably in the 4-position.

For use herein the term "the aryl, heteroaryl, and heterocyclic containing moieties" refers to both the ring and the alkyl, or if included, the alkenyl rings, such as aryl, arylalkyl, and aryl alkenyl rings. The term "moieties" and "rings" may be interchangeably used throughout.

Suitably, s is an integer having a value of 1 to 3.

It is recognized that R₁ moiety may be substituted on either the benzene ring or the X containing ring, if possible.

When R₁ forms a dioxybridge, s is preferably 1. When R₁ forms an additional unsaturated ring, it is preferably 6 membered resulting in a naphthylene ring system. These ring systems may be substituted independently, 1 to 3 times by the other R₁ moieties as defined above.

Suitably, R₄ and R₅ are independently hydrogen, optionally substituted C₁-4 alkyl, optionally substituted aryl, optionally substituted aryl C₁-4alkyl, optionally substituted heteroaryl, optionally substituted heteroaryl C₁-4alkyl, heterocyclic, or heterocyclicC₁-4 alkyl, or R₄ and R₅ together with the nitrogen to which they are attached form a 5 to 7 member ring which may optionally comprise an additional heteroatom selected from O/N/S.

Suitably, R₆ and R₇ are independently hydrogen or a C₁-4 alkyl group, or R₆ and R₇ together with the nitrogen to which they are attached form a 5 to 7 member ring which ring may optionally contain an additional heteroatom which heteroatom is selected from oxygen, nitrogen or sulfur.

Suitably, R₈ is independently hydrogen or C₁-4 alkyl.

Suitably, q is 0 or an integer having a value of 1 to 10.

Suitably, R₁₀ is C₁₋₁₀ alkyl C(O)R₈, such as CH₂C(O)H or CH₂C(O)CH₃.

Suitably, R₁₁ is hydrogen, C₁₋₄ alkyl, aryl, aryl C₁₋₄ alkyl, heteroaryl, heteroaryl C₁₋₄alkyl, heterocyclic, or heterocyclic C₁₋₄alkyl.

5 Suitably, R₁₂ is hydrogen, C₁₋₁₀ alkyl, optionally substituted aryl or optionally substituted arylalkyl.

Suitably, R₁₃ and R₁₄ are independently hydrogen, or an optionally substituted C₁₋₄ alkyl which may be straight or branched as defined herein, or one of R₁₃ and R₁₄ are an optionally substituted aryl.

Suitably, v is 0, or an integer having a value of 1 to 4.

10 When R₁₃ or R₁₄ are an optionally substituted alkyl, the alkyl moiety may be substituted one to three times independently by halogen; halosubstituted C₁₋₄ alkyl such as trifluoromethyl; hydroxy; hydroxy C₁₋₄alkyl, C₁₋₄ alkoxy; such as methoxy, or ethoxy, halosubstituted C₁₋₁₀ alkoxy, S(O)₁₋₄R₄; aryl; NR₄R₅; NHC(O)R₄; C(O)NR₄R₅; or C(O)OR₈.

15 Suitably, R₁₇ is C₁₋₄alkyl, aryl, arylalkyl, heteroaryl, heteroarylC₁₋₄alkyl, heterocyclic, or heterocyclicC₁₋₄alkyl, wherein all of the aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted.

20 Suitably, Y is independently selected from hydrogen; halogen; nitro; cyano; halosubstituted C₁₋₁₀ alkyl; C₁₋₁₀ alkyl; C₂₋₁₀ alkenyl; C₁₋₁₀ alkoxy; halosubstituted C₁₋₁₀ alkoxy; azide; (CR₈R₈)_q S(O)₁₋₄R₄; hydroxy; hydroxyC₁₋₄alkyl; aryl; aryl C₁₋₄ alkyl; aryloxy; arylC₁₋₄ alkyloxy; heteroaryl; heteroarylalkyl; heteroaryl C₁₋₄ alkyloxy; heterocyclic, heterocyclic C₁₋₄alkyl; aryl C₂₋₁₀ alkenyl; heteroaryl C₂₋₁₀ alkenyl; heterocyclic C₂₋₁₀ alkenyl; (CR₈R₈)_q NR₄R₅; C₂₋₁₀ alkenyl C(O)NR₄R₅; (CR₈R₈)_q C(O)NR₄R₅; (CR₈R₈)_q C(O)NR₄R₁₀; S(O)₃H; S(O)₃R₈; (CR₈R₈)_q C(O)R₁₁; C₂₋₁₀ alkenyl C(O)R₁₁; C₂₋₁₀ alkenyl C(O)OR₁₁; (CR₈R₈)_q C(O)OR₁₂; (CR₈R₈)_q OC(O) R₁₁; (CR₈R₈)_qC(NR₄)NR₄R₅; (CR₈R₈)_q NR₄C(NR₅)R₁₁; (CR₈R₈)_q NR₄C(O)R₁₁; (CR₈R₈)_q NHS(O)₂R_a; or (CR₈R₈)_q S(O)₂NR₄R₅; or two Y moieties together may form O-(CH₂)_s-O or a 5 to 6 membered saturated or unsaturated ring. The aryl, heteroaryl and heterocyclic containing moieties noted above may all be optionally substituted as defined herein.

25 When Y forms a dioxybridge, s is preferably 1. When Y forms an additional unsaturated ring, it is preferably 6 membered resulting in a naphthylene ring system. These ring systems may be substituted 1 to 3 times by other Y moieties as defined above.

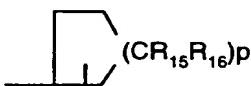
Suitably, R_a is NR₆R₇, alkyl, aryl C₁₋₄ alkyl, arylC₂₋₄ alkenyl, heteroaryl, heteroaryl-C₁₋₄alkyl, heteroarylC₂₋₄ alkenyl, heterocyclic, heterocyclicC₁₋₄ alkyl, wherein all of the aryl, heteroaryl and heterocyclic containing rings may all be optionally substituted.

30 Y is preferably a halogen, C₁₋₄ alkoxy, optionally substituted aryl, optionally substituted aryloxy or arylalkoxy, methylene dioxy, NR₄R₅, thio C₁₋₄alkyl, thioaryl, halosubstituted alkoxy, optionally substituted C₁₋₄ alkyl, or hydroxy alkyl. Y is more preferably mono-substituted halogen, disubstituted halogen, mono-substituted alkoxy,

disubstituted alkoxy, methylenedioxy, aryl, or alkyl, more preferably these groups are mono or di-substituted in the 2'- position or 2', 3'-position on a phenyl ring.

While Y may be substituted in any of the ring positions, n is preferably one. While both R₁ and Y can both be hydrogen, it is preferred that at least one of the rings be substituted, preferably both rings are substituted.

Suitably, R is -NH-C(X₂)-NH-(CR₁₃R₁₄)_v-Z.



Suitably, Z is W, HET, (Y)n, an optionally substituted C₁₋₁₀ alkyl, an optionally substituted C₂₋₁₀ alkenyl, or an optionally substituted C₂₋₁₀ alkynyl.

Suitably, p is an integer having a value of 1 to 3.

X₂ is suitably =O, or =S.

In compounds of Formula (I), suitably X is C(X₁)₂, C(O), C(S), S(O)₂, PO(OR₄) or C=N-R₁₉.

Suitably, R₁₉ is cyano, nitro, S(O)₂NR₄R₅, S(O)₂R₁₇, alkyl, arylC₁₋₄ alkyl, arylC₂₋₄ alkenyl, heteroaryl, heteroaryl-C₁₋₄alkyl, heteroarylC₂₋₄ alkenyl, heterocyclic, heterocyclicC₁₋₄ alkyl, wherein the alkyl, aryl, heteroaryl and heterocyclic containing rings may all be optionally substituted. Preferably R₁₉ is cyano.

When X is C(X₁)₂, X₁ is suitably independently hydrogen, halogen, NR₄R₅, C₁₋₁₀ alkylNR₄R₅, C(O)NR₄R₅, C₁₋₁₀ alkyl-C(O)NR₄R₅, optionally substituted C₁₋₁₀ alkyl, C₁₋₁₀ alkoxy; halosubstituted C₁₋₁₀ alkoxy, aryl; aryl C₁₋₄ alkyl; aryloxy; aryl C₁₋₄ alkyloxy; heteroaryl; heteroarylalkyl; heterocyclic, heterocyclic C₁₋₄alkyl; or heteroaryl C₁₋₄ alkyloxy. The C₁₋₁₀ alkyl group may be optionally substituted one or more times by hydroxy, NR₄R₅, or halogen. Preferably, at least one of X₁ is hydrogen.

Preferably, for compounds of Formula (I), X is C(S) or a C(O) moiety, more preferably C(O).

Suitably, R₁₈ is hydrogen, optionally substituted C₁₋₁₀ alkyl, C₁₋₁₀ alkoxy, halosubstituted C₁₋₁₀ alkoxy, hydroxy, arylC₁₋₄ alkyl, arylC₂₋₄ alkenyl, heteroaryl, heteroaryl-C₁₋₄alkyl, heteroarylC₂₋₄ alkenyl, heterocyclic, or heterocyclicC₁₋₄ alkyl, wherein all of the aryl, heteroaryl and heterocyclic rings may all be optionally substituted. Preferably R₁₈ is hydrogen or alkyl, more preferably hydrogen.

In compounds of Formula (II), suitably X is N, or C(X₁), preferably X is N.

Preferably, when X is C(X₁), X₁ is hydrogen or halosubstituted alkyl.

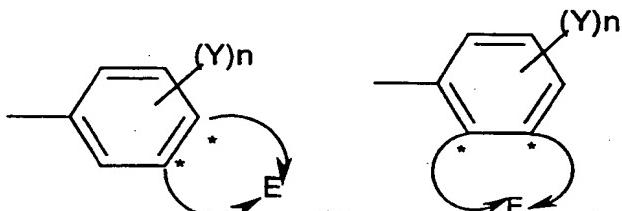
It is recognized that in compounds of Formula (II) that the ring system can exist in a tautomeric form.

Suitably when Z is a heteroaryl (HET) ring, it is suitably a heteroaryl ring or ring system. If the HET moiety is a multi ring system, the ring containing the heteroatom does not need to be directly attached to the urea moiety through the (R₁₃R₁₄)_v linkage of the ring(s) in

these ring systems may be optionally substituted as defined herein. Preferably the HET moiety is a pyridyl, which may be 2-, 3- or 4-pyridyl. If the ring is a multi system ring it is preferably benzimidazole, dibenzothiophene, or an indole ring. Other rings of interest include, but are not limited to thiophene, furan, pyrimidine, pyrrole, pyrazole, quinoline, isoquinoline, 5 quinazolinyl, oxazole, thiazole, thiadiazole, triazole, imidazole, or benzimidazole.

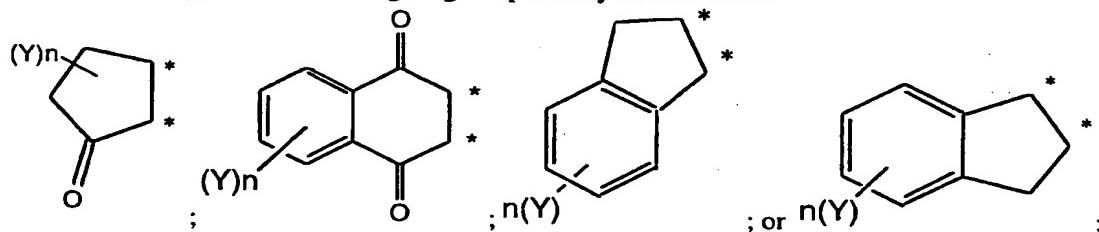
The HET ring may be optionally substituted independently one to five, preferably 1 to 3 times by Y as defined above. The substitutions may be in any of the ring(s) of the HET system, such as in a benzimidazole ring.

Suitably R₁₅ and R₁₆ are independently hydrogen, or an optionally substituted C₁₋₄ 10 alkyl as defined above for R₁₃ and R₁₄.



Suitably, W is

Suitably, the E containing ring is optionally selected from



the asterix * denoting point of attachment of the ring.

15

The E ring denoted by its point of attachment through the asterix (*) may optionally be present. If it is not present the ring is a phenyl moiety which is substituted by the R₁ terms as shown. The E ring may be substituted by the (Y)n moiety in any ring, saturated or unsaturated, and is shown for purposes herein substituted only in the unsaturated ring(s).

20

While Y in the W term may be substituted in any of the 5 ring positions of the phenyl moiety (when E is absent), Y is preferably mono-substituted in the 2'-position or 3'-position, with the 4'-preferably being unsubstituted. If the phenyl ring is disubstituted, substituents are preferably in the 2' or 3' position of a monocyclic ring. While both R₁ and Y can both be hydrogen, it is preferred that at least one of the rings be substituted, preferably both rings are substituted.

25

As used herein, "optionally substituted" unless specifically defined shall mean such groups as halogen, such as fluorine, chlorine, bromine or iodine; hydroxy; hydroxy substituted C₁₋₁₀alkyl; C₁₋₁₀ alkoxy, such as methoxy or ethoxy; S(O)_m'C₁₋₁₀ alkyl, wherein m' is 0, 1 or 2, such as methyl thio, methyl sulfinyl or methyl sulfonyl; amino, mono & di-substituted amino, such as in the NR₄R₅ group; NHC(O)R₄; C(O)NR₄R₅; C(O)OH; S(O)₂NR₄R₅;

NHS(O)2R₂₀, C₁₋₁₀ alkyl, such as methyl, ethyl, propyl, isopropyl, or t-butyl; halosubstituted C₁₋₁₀ alkyl, such as CF₃; an optionally substituted aryl, such as phenyl, or an optionally substituted arylalkyl, such as benzyl or phenethyl, optionally substituted heterocyclic, optionally substituted heterocyclicalkyl, optionally substituted heteroaryl, optionally substituted heteroaryl alkyl, wherein these aryl, heteroaryl, or heterocyclic moieties may be substituted one to two times by halogen; hydroxy; hydroxy substituted alkyl; C₁₋₁₀ alkoxy; S(O)_mC₁₋₁₀ alkyl; amino, mono & di-substituted amino, such as in the NR₄R₅ group; C₁₋₁₀ alkyl, or halosubstituted C₁₋₁₀ alkyl, such as CF₃.

5 R₂₀ is suitably C₁₋₄ alkyl, aryl, aryl C₁₋₄alkyl, heteroaryl, heteroarylC₁₋₄alkyl, heterocyclic, or heterocyclicC₁₋₄alkyl.

10 Suitable pharmaceutically acceptable salts are well known to those skilled in the art and include basic salts of inorganic and organic acids, such as hydrochloric acid, hydrobromic acid, sulphuric acid, phosphoric acid, methane sulphonic acid, ethane sulphonic acid, acetic acid, malic acid, tartaric acid, citric acid, lactic acid, oxalic acid, succinic acid, fumaric acid, 15 maleic acid, benzoic acid, salicylic acid, phenylacetic acid and mandelic acid. In addition, pharmaceutically acceptable salts of compounds of Formula (I) may also be formed with a pharmaceutically acceptable cation, for instance, if a substituent group comprises a carboxy moiety. Suitable pharmaceutically acceptable cations are well known to those skilled in the art and include alkaline, alkaline earth, ammonium and quaternary ammonium cations.

20 The following terms, as used herein, refer to:

- "halo" - all halogens, that is chloro, fluoro, bromo and iodo.
- "C₁₋₁₀alkyl" or "alkyl" - both straight and branched chain radicals of 1 to 10 carbon atoms, unless the chain length is otherwise limited, including, but not limited to, methyl, ethyl, n-propyl, iso-propyl, n-butyl, sec-butyl, iso-butyl, tert-butyl, n-pentyl and the like.

25 • "cycloalkyl" is used herein to mean cyclic radicals, preferably of 3 to 8 carbons, including but not limited to cyclopropyl, cyclopentyl, cyclohexyl, and the like.

• "alkenyl" is used herein at all occurrences to mean straight or branched chain radical of 2-10 carbon atoms, unless the chain length is limited thereto, including, but not limited to ethenyl, 1-propenyl, 2-propenyl, 2-methyl-1-propenyl, 1-butenyl, 2-butenyl and the like.

30 • "aryl" - phenyl and naphthyl;

• "heteroaryl" (on its own or in any combination, such as "heteroaryloxy", or "heteroaryl alkyl") - a 5-10 membered aromatic ring system in which one or more rings contain one or more heteroatoms selected from the group consisting of N, O or S, such as, but not limited, to pyrrole, pyrazole, furan, thiophene, quinoline, isoquinoline, quinazolinyl, 35 pyridine, pyrimidine, oxazole, thiazole, thiadiazole, triazole, imidazole, or benzimidazole.

• "heterocyclic" (on its own or in any combination, such as "heterocyclicalkyl") - a saturated or partially unsaturated 4-10 membered ring system in which one or more rings contain one or more heteroatoms selected from the group consisting of N, O, or S; such as, but

not limited to, pyrrolidine, piperidine, piperazine, morpholine, tetrahydropyran, or imidazolidine.

• "arylalkyl" or "heteroarylalkyl" or "heterocyclicalkyl" is used herein to mean C₁-10 alkyl, as defined above, attached to an aryl, heteroaryl or heterocyclic moiety, as also defined herein, unless otherwise indicated.

5 • "sulfinyl" - the oxide S (O) of the corresponding sulfide, the term "thio" refers to the sulfide, and the term "sulfonyl" refers to the fully oxidized S(O)₂ moiety.

10 • "wherein two R₁ moieties (or two Y moieties) may together form a 5 or 6 membered saturated or unsaturated ring" is used herein to mean the formation of an aromatic ring system, such as naphtylene, or is a phenyl moiety having attached a 6 membered partially saturated or unsaturated ring such as a C₆ cycloalkenyl, i.e. hexene, or a C₅ cycloalkenyl moiety, such as cyclopentene.

Exemplified compounds of Formula (I) include:

N-4-(Benzimidazole-2-one-N'-(2'-bromophenyl)urea;

15 N-4-(1H,3H-2,1,3-benzothiazole 2,2-dioxide)-N'-(2-bromophenyl) urea

N-4-(7-Cyano-1-N-methyl-benzimidazole-2-thione)-N'-(2,3-dichlorophenyl) urea

N-4-(7-Cyano-benzimidazole-2-thione)-N'-(2 bromophenyl) urea

N-4-(7-Cyano-1-methyl-benzimidazole-2-thione)-N'-(2 bromophenyl) urea

N-4-(7-Cyano-1-methylbenzimidazole-2-one)-N'-(2,3-dichlorophenyl) urea

20 N-4-(7-Cyano-benzimidazole-2-one)-N'-(2-bromophenyl)urea

N-4-(7-Cyano-benzimidazole-2-thione)-N'-(2,3-dichlorophenyl) urea

N-4-(7-Cyano benzimidazole-2-imine)-N'-(2-bromophenyl) urea; and

N-(4-Cyano-2-oxo-3-methylbenzimidazol-7-yl)-N'-(2-bromophenyl) urea.

Exemplified compounds of Formula (II) include:

25 N-7-(Benzotriazole)-N'-(2-bromophenyl)urea;

N-7-(4-Bromobenzotriazole)-N'-(2,3-dichlorophenyl)urea;

N-7-(4-Bromo-2-trifluoromethyl-benzimidazolyl)-N'-(2-bromophenyl)urea;

N-4-(2-Trifluoromethyl-benzimidazolyl)-N'-(2-bromophenyl)urea

N-7-(4-Cyano-benzotriazole)-N'-(2,3-dichlorophenyl) urea

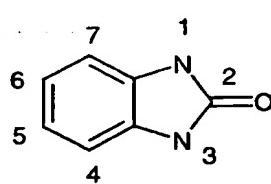
30 N-7-(4-Cyano-benzotriazole)-N'-(2-bromophenyl)urea

N-7-(4-Cyano-2-trifluoromethyl-benzimidazolyl)-N'-(2-bromophenyl)urea

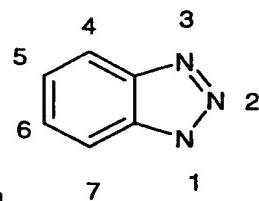
N-7-(4-Cyano-benzimidazolyl)-N'-(2,3-dichlorophenyl) urea; and

N-7-(4-Cyano-benzimidazolyl)-N'-(2-bromophenyl) urea.

35 For purposes herein, the above noted nomenclature is based upon the numbering of the ring systems as follows:



(for Formula (I)); and



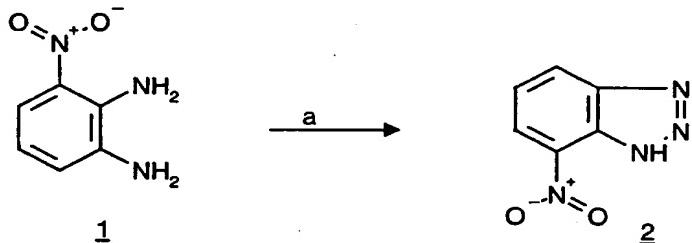
(for Formula (II)).

METHODS OF PREPARATION

The compounds of Formula (I) may be obtained by applying synthetic procedures, some of which are illustrated in the Schemes below. The synthesis provided for in these Schemes is applicable for the producing of Formula (I) having a variety of different Z and R₁ groups which are reacted, employing optional substituents which are suitably protected to achieve compatibility with the reactions outlined herein. Subsequent deprotection, in those cases, then affords compounds of the nature generally disclosed. Once the urea nucleus has been established, further compounds of these formulas may be prepared by applying standard techniques for functional group interconversion, well known in the art. While the schemes are shown with various compounds of Formula (I) this is merely for illustration purposes only and not a limitation on the extent of synthesis available using these methods.

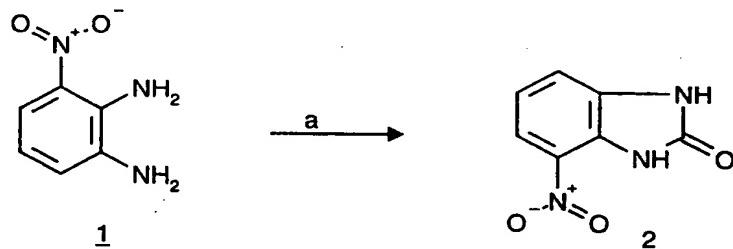
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Scheme 1

a)NaNO₂, HOAc

If the 2-nitro substituted heterocyclic compound 2-scheme 1 is not commercially available it can be made by treating the commercially available 3-nitro phenylene diamine 1-scheme 1 with sodium nitrite in a protic solvent such as HOAc.

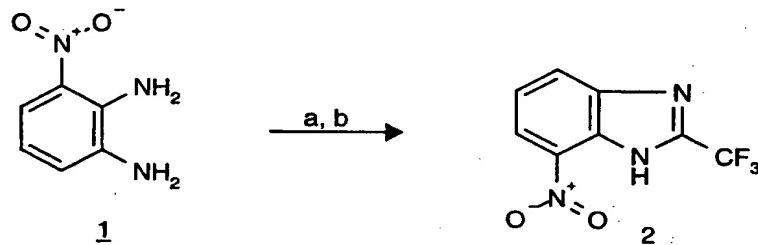
Scheme 2



a)Triphosgene, Et₃N, DMF

If the 2-nitro substituted heterocyclic compound 2-scheme 2 is not commercially available it can be made by treating the commercially available 3-nitro phenylene diamine 1-scheme 2 with triphosgene and triethylamine in DMF or the thiophosgene to form the thio urea. Or alternatively with another carbonyl with no leaving groups such as carbonyl di-imidazole.

Scheme 3



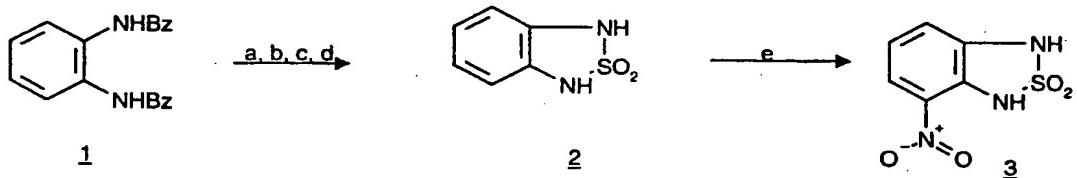
a)Trifluoroacetic anhydride b)Toluene, reflux

10

If the 2-nitro substituted heterocyclic compound 2-scheme 3 is not commercially available it can be made by treating the commercially available 3-nitro phenylene diamine 1-scheme 3 with the corresponding anhydride then refluxing in toluene.

Scheme 4

15



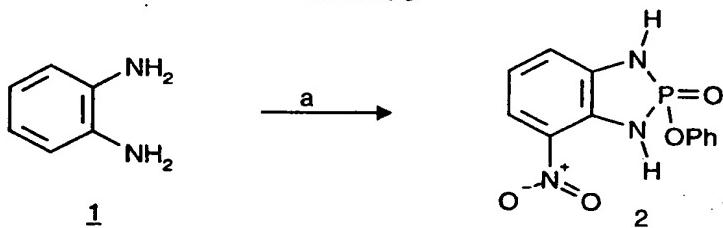
a) Et₃N, THF, -70°C b) SOCl₂ c) m-CPBA d) H₂, Pd/C e) NaNO₃, 3M H₂SO₄

If the 2-nitro substituted heterocyclic compound 3-scheme 4 is not commercially available it can be made by treating compound 2-scheme 4, under standard nitrating conditions

(using HNO_3 or NaNO_3) at 23°C . If heterocyclic compound 2-scheme 4 is not commercially available it can be made from the commercially available 1, 2-dibenzylidiamine 1-scheme 4 with triethylamine at -70°C , then thionyl chloride followed by oxidation with m-CPBA and reduction of the benzyl groups using H_2/Pd in MeOH.

5

Scheme 5

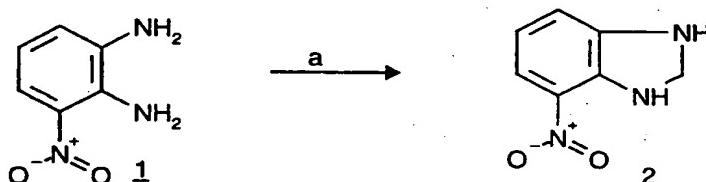


a) PhOP(O)Cl_2 b) NaNO_3

If the 2-nitro substituted heterocyclic compound 2-scheme 5 is not commercially available it can be made by treating the commercially available 1, 2-diamine 1-scheme 5 with PhOP(O)Cl_2 followed by standard nitrating conditions (using HNO_3 or NaNO_3) at 23°C .

10

Scheme 6

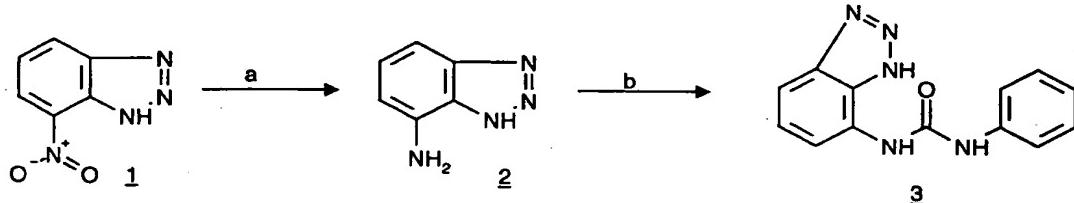


a) Formaldehyde, reflux

If the heterocyclic compound 2-scheme 6 is not commercially available it can be made by treating the commercially available 1, 2-diamine 1-scheme 6 with formaldehyde at reflux.

15

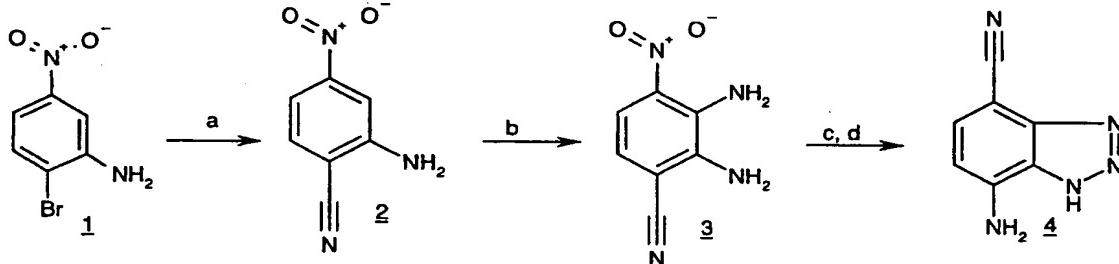
Scheme 7



a) $\text{H}_2/\text{Pd/C, MeOH}$ b) $\text{PhNCO, DMF, } 80^\circ\text{C}$

If the desired aniline 2-scheme 7 is not commercially available the corresponding nitro compound 1-scheme 4 is then reduced under standard condition (H_2 Pd/C or $SnCl_2$). The ortho substituted phenyl urea in 3-scheme 7 may be prepared by standard conditions involving the condensation of the commercially available substituted aryl isocyanate(Aldrich Chemical Co., Milwaukee,Wi.) with the corresponding aniline 2-scheme 7 in an aprotic solvent such as (DMF or toluene).

Scheme 8



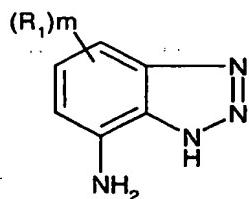
a) CuCN,pyridine,DMF b)TMHI,DMSO,Na-tertpentoxide c) $NaNO_2$, $HOAc$ d) Pd/C H_2 $MeOH$

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If the 7-amino substituted heterocyclic compound 4-scheme 8 is not commercially available it can be made by treating the commercially available 2-bromo-5-nitroaniline 1-scheme 8 with a nucleophile such as, copper (I) cyanide or alternatively this can be used for palladium catalysized coupling reactions, and pyridine in an aprotic solvent such as DMF to form the 2-cyano-5-nitroaniline 2-scheme 8. The diamine 3-scheme 8 can be formed by reacting 2-cyano-5-nitroaniline 2-scheme 8 with tetramethyl hydrazine iodide and a strong hindered base such as sodium t-pentoxide, in an aprotic solvent such as DMSO. The 7-amino-4-cyanobenzotriazole 4-scheme 8 can be made by reacting the diamine 3-scheme 8 with sodium nitrite, in a protic solvent such as $HOAc$, followed by reduction of the nitro group with a suitably reducing agent, such as Pd/C in $MeOH$. Alternatively the diamine 3-Scheme 8 can be used to synthesize the other named heterocyclics described herein. The aromatic rings of the compounds can be further functionalized by conditions well known in the art such as bromination or other electrophilic substitution reactions. These substituents can be further manipulated using standard nucleophilic substitutions such as reaction with an anion (such as sodium methoxide), or in palladium catalyzed coupling reaction chemistry.

The amino substituted heterocyclic compound 4-scheme-8 can then be converted to the corresponding urea by condensation with a commercially available isocyanate.

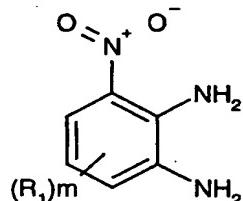
Another aspect of the present invention are the novel compounds of the formula:



wherein R₁ and m are as defined in Formula (II). Preferably, R₁ is bromo or cyano.

Preferably R₁ is substituted in the 4-position of the ring.

Another aspect of the present invention are the novel compounds of Formula (IV):

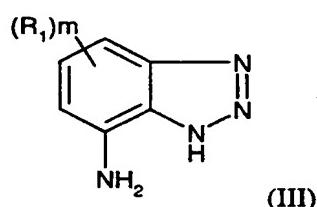


wherin R₁ and m are as defined for Formula (II), provided that R₁ is other than hydrogen.

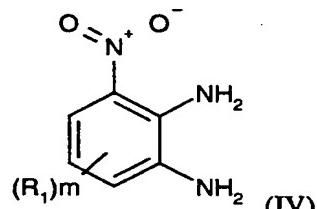
Preferably R₁ is cyano, or bromo.

Another aspect of the present invention is the novel process of making a compound of the formula:

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by reacting a compound of the formula:

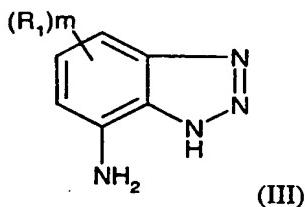


with sodium nitrite in a protic solvent, followed by reduction of the nitro group to yield a

15 compound of Formula (III).

Lastly, another aspect of the present invention is the analogous process for producing a compound of Formula (II) as defined above, which process comprises

a) reacting a compound of the formula:



with a compound of the formula:

$C(X_2)-N-(CR_{13}R_{14})_v - Z$; wherein R_1 , m , X_2 , R_{13} , R_{14} , v and Z are as defined in Formula (II) to yield a compound of Formula (II).

5

SYNTHETIC EXAMPLES

The invention will now be described by reference to the following examples which are merely illustrative and are not to be construed as a limitation of the scope of the present invention. All temperatures are given in degrees centigrade, all solvents are highest available purity and all reactions 10 run under anhydrous conditions in an argon atmosphere unless otherwise indicated.

In the Examples, all temperatures are in degrees Centigrade ($^{\circ}\text{C}$). Mass spectra were performed upon a VG Zab mass spectrometer using fast atom bombardment, unless otherwise indicated. $^1\text{H-NMR}$ (hereinafter "NMR") spectra were recorded at 250 MHz using a Bruker AM 250 or Am 400 spectrometer. Multiplicities indicated are: s=singlet, d=doublet, t=triplet, q=quartet, 15 m=multiplet and br indicates a broad signal. Sat. indicates a saturated solution, eq indicates the proportion of a molar equivalent of reagent relative to the principal reactant.

General Method B: Synthesis of N, N'- phenyl urea To a solution of phenyl isocyanate(1.0 equiv.) in dimethyl formamide (1ml) the corresponding aniline (1.0 equiv.) was added. The reaction mixture was stirred at 80°C until complete (3-16 hours), then removed 20 solvent under vacuum. The purification, yields and spectral characteristics for each individual compound are listed below.

Example I

Preparation of N-[5-Bromo-2-benzotriazole]-N'-[2, 3-dichlorophenyl] urea

25 a) Preparation of 4-nitrobenzotriazole

To a solution of 3-nitro-phenylenediamine(15.3g, 100 millimole (hereinafter mmol)) in acetic acid (50milliliter (hereinafter "ml")) was stirred with sodium nitrite(6.9g, 100 mmol). The mixture was then heated to 60°C for 1 hour (hereinafter "hr"). The reaction was then cooled to room temperature and water was added, the desired product precipitated out of 30 solution and the mixture was filtered to give the desired product(10.7 grams (hereinafter "g"), 65 %). $^1\text{H NMR}$ (CD_3SOCD_3): δ 8.58 (d, 1H), 8.44 (d, 1H), 7.61 (t, 1H).

b) Preparation of 4-aminobenzotriazole

To a solution of 4-nitrobenzotriazole(4g, 24.4mmol) in methanol(250ml) was added 10% Pd/C (1.0g). The mixture was flushed with argon, then hydrogen was bubbled through 35 the solution for 10 minutes (hereinafter "min") and a hydrogen atmosphere was maintained at

balloon pressure for 4 hrs. The reaction mixture was flushed with argon and 10% Pd/C (1.0g) was additionally added and a hydrogen atmosphere was maintained at balloon pressure overnight. The mixture was filtered through celite and the celite was washed with methanol. The solvent was evaporated and chromatography of the resulting solid on silica gel (5%MeOH/ CH₂Cl₂) gave the desired product(2.0g, 82 %). ¹H NMR (CD₃SO₂CD₃): δ 8.71 (s, 1H), 7.16 (t, 1H), 6.75 (d, 1H), 6.36 (d, 1H), 5.90 (s, 1H).

5 c) Preparation of 4-amino-7-bromobenzotriazole

To a solution of 4-aminobenzotriazole(550 milligram (hereinafter "mg"), 4.1mmol) in acetic acid (10ml) was added potassium bromide (520mg, 4.4mmol), ammonium 10 molybdate(67mg, 0.55mmol) and hydrogen peroxide (0.5ml, 30%). The mixture was stirred at 25° C for 3 hrs. The solvent was evaporated and chromatography of the resulting solid on silica gel (EtOAc/ Hexane(1equiv./1equiv.)) gave the desired product(400 mg, 45 %). ¹H NMR (CD₃SO₂CD₃): δ 7.29 (d, 1H), 6.49 (d, 1H), 6.05 (bs, 3H).

15 d) Preparation of N-7-[4-Bromo-[2,4]-benzotriazole]-N'-[2, 3-dichlorophenyl] urea

N-[5-Bromo-2-benzotriazole]-N'-[2, 3-dichlorophenyl] urea was prepared from 4-amino-7-bromobenzotriazole (330mg, 1.50 mmol) according to the procedure in General Method B. The product was purified by chromatography of the resulting solid on silica gel(EtOAc/ hexane(2equiv./3equiv.)). (410mg, 68%). ¹H NMR (CD₃SOCD₃): δ 10.42 (s, 1H), 9.25 (s, 1H), 8.20 (dd, 1H), 7.96 (d, 1H), 7.64 (d, 1H), 7.33 (m, 2H).

20 Example 2

Preparation of N-7-[benzimidazolin-3-one]-N'-[2-bromophenyl] urea

a) Preparation of 4-nitro-benzimidazolin-2-one

To a solution of 3-nitro-phenylenediamine(1.0g, 6.53 mmol) in dimethylforamide(20ml) was added triphosgene(0.775g, 2.60 mmol)and triethylamine(1ml, 7.80mmol). The mixture was 25 then heated to 80° C for about1 hour. The solvents were then evaporated and the product was precipitated out of solution with methylene chloride/hexane(1equiv./20equiv.). (700mg, 64%). ¹H NMR (CD₃SO₂CD₃): δ 11.61 (s, 1H), 11.35 (s, 1H), 7.85 (d, 1H), 7.34 (d,1H), 7.15 (t, 1H).

b) Preparation of 4-amino-benzimidazolin-2-one

To a solution of 4-nitro-benzimidazolin-2-one (700mg, 3.9mmol) in 30 methanol(50ml)and acetic acid(10ml) was added 10% Pd/C (200mg). The mixture was flushed with argon, then hydrogen was bubbled through the solution for 10 min. and a hydrogen atmosphere was maintained at balloon pressure overnight. The mixture was filtered through celite and the celite was washed with methanol. The solvent was evaporated and chromatography of the resulting solid on silica gel (10%MeOH/ CH₂Cl₂) gave the desired 35 product(500mg, 86 %). ¹H NMR (CD₃SO₂CD₃): δ 10.34 (s, 1H), 10.01 (s, 1H), 6.66 (t, 1H), 6.24 (d,1H), 6.22 (d, 1H), 5.15 (bs, 2H).

c) Preparation of N-[benzimidazolin-3-one]-N'-[2-bromophenyl] urea

N-[benzimidazolin-3-one]-N'-[2-bromophenyl] urea was prepared from 4-amino-benzimidazolin-2-one (80mg, 0.54 mmol) according to the procedure in General Method B.

The product was purified by chromatography of the resulting solid on silica gel(EtOAc/hexane(1equiv./1equiv.)). (120mg, 64%). ^1H NMR (CD_3SOCD_3): δ 10.68 (s, 1H), 10.03 (s, 1H), 9.08 (s, 1H), 8.15 (d, 1H), 8.08 (s, 1H), 7.62 (d, 1H), 7.34 (t, 1H), 6.99 (t, 1H), 6.92 (d, 2H), 6.73 (d, 1H).

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Example 3Preparation of N-[4-bromo-2-trifluoromethyl-7-benzimidazolyl]-N'-[2-bromophenyl] urea

a) Preparation of 4-nitro-2-trifluoromethylbenzimidazole

To a solution of 3-nitro-phenylenediamine(1.0g, 6.53 mmol) was added trifluoroacetic anhydride(1.37g, 6.53mmol). The mixture was then stirred for 1 hr. The solvents were then evaporated and the product was refluxed in toluene for 2 hrs. The solvents were then evaporated and the desired product was obtained(1.43g, 95%). ^1H NMR ($\text{CD}_3\text{SO}_2\text{CD}_3$): δ 9.40 (s, 1H), 8.31 (d, 1H), 8.39 (d, 1H), 7.58 (t, 1H).

b) Preparation of 4-amino-2-trifluoromethylbenzimidazole

To a solution of 4-nitro-2-trifluoromethylbenzimidazole (700mg, 3.0mmol) in methanol(50ml)and was added 10% Pd/C (200mg). The mixture was flushed with argon, then hydrogen was bubbled through the solution for 10 min. and a hydrogen atmosphere was maintained at balloon pressure overnight. The mixture was filtered through celite and the celite was washed with methanol. The solvent was evaporated and chromatography of the resulting solid on silica gel (10%MeOH/ CH_2Cl_2) gave the desired product(560mg, 93 %). ^1H NMR ($\text{CD}_3\text{SO}_2\text{CD}_3$): δ 10.49 (s, 1H), 7.09 (t, 1H), 6.72 (d, 1H), 6.30 (d, 1H), 5.52 (bs, 2H).

c) Preparation of 4-amino-7-bromo-2-trifluoromethylbenzimidazole

To a solution of 4-amino-2-trifluoromethylbenzimidazole (180mg, 0.9mmol) in acetic acid(10ml) was added potassium bromide(117mg, 0.99mmol), ammonium molybdate(12mg, 0.099mmol) and hydrogen peroxide(0.2ml,30%). The mixture was stirred at 25°C for 3 hrs. The solvent was evaporated and chromatography of the resulting solid on silica gel (EtOAc/ Hexane(1equiv./1equiv)) gave the desired product(103mg, 39 %). ^1H NMR (CD_3OD): δ 7.11 (d, 1H), 6.35 (d, 1H).

d) Preparation of N-[4-bromo-2-trifluoromethyl-7-benzimidazolyl]-N'-[2-bromophenyl] urea

N-[4-bromo-2-trifluoromethyl-7-benzimidazolyl]-N'-[2-bromophenyl] urea was prepared from 4-amino-7-bromo-2-trifluoromethylbenzimidazole (33mg, 0.54 mmol) according to the procedure in General Method B. The product was purified by chromatography of the resulting solid on silica gel(EtOAc/ hexane (1equiv./1equiv.)). (35mg, 63%). ^1H NMR (CD_3SOCD_3): δ 9.95 (s, 1H), 9.54 (s, 1H), 9.07 (s, 1H), 8.06 (d, 1H), 7.99 (d, 1H), 7.62 (d, 1H), 7.33 (t, 1H), 7.01 (t, 1H).

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Example 4Preparation of N-[4-Triazolophenyl]-N'-[2-bromophenyl] urea

a) Preparation of 2, 6-Dinitro(1-phenylsulfonyl)aniline

To the solution of 2, 6-dinitroaniline (2 g, 10.92 mmol) in THF (20 mL), sodium hydride (437 mg, 10.92 mmol) was added. After 10 minutes, benzenesulfonyl chloride (1.4

mL, 10.92 mmol) was added. The reaction mixture was stirred at room temperature for 16 hours. Then, the reaction mixture was partitioned between ethyl acetate and water. The combined organic layer was dried over MgSO₄, filtered and concentrated under reduced pressure and chromatography of the resulting liquid on silica gel (hexane/ethyl acetate(5equiv./1equiv.)) gave product (2.6 g, 74%). EI-MS m/z 324 (M⁺).

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b) Preparation of 2, 6-Diamino(1-phenylsulfonyl)aniline

To the solution of 2, 6-Dinitro(1-phenylsulfonyl)aniline (450 mg, 1.39 mmol) in ethanol (10 mL), Tin (II) chloride (1.57 g, 6.95 mmol) was added. The reaction mixture was stirred at reflux for 4 hours. Then was cooled to room temperature. The NaHCO₃ (aqueous) was added to pH= 7. Then was extracted with ethyl acetate (3x). The combined organic layer was dried over MgSO₄, filtered and concentrated under reduced pressure to give product (338mg, 92%). EI-MS m/z 264 (M⁺).

10 c) Preparation of N-(2-Benzenesulfonylamino-3-aminophenyl)-N'-(2-bromophenyl)urea

To a solution of 2-bromo phenyl isocyanate (0.16 mg, 1.28 mmol) in DMF (1.5 mL), the 2, 6-diamino(1-phenylsulfonyl)aniline (338 mg, 1.28 mmol) was added. The reaction mixture was stirred at 80°C for 16 hours, then cooled to room temperature. Chromatography of the resulting liquid on silica gel (hexane/ethyl acetate(5equiv./1equiv. to 1equiv./1equiv.)) gave product (430 mg, 73%). EI-MS m/z 461 (M⁺).

d) Preparation of N-(4-Triazolophenyl)-N'-(2-bromophenyl)urea

The N-(2-Benzenesulfonylamino-3-aminophenyl)-N'-(2-bromophenyl)urea (235 mg, 0.51 mmol) was added to HCl/H₂O (0.51 mL/1.02 mL), cooled to 0°C. Sodium nitrate (35.4 mg, 0.51 mmol) was added to the reaction mixture. The reaction mixture was stirred at 0°C for 30 minutes. The sodium cyanide (25 mg, 0.51 mmol) was added to reaction mixture and warmed to room temperature. The reaction mixture was stirred at room temperature for 18 hours. Then it was extracted with three times by ethyl acetate. The organic extracts were combined, dried over MgSO₄, filtered and concentrated under reduced pressure and chromatography of the resulting solid on silica gel gave product (100 mg, 59%). EI-MS m/z 333 (M⁺).

Example 5

30 a) Preparation of N-7-[2-trifluoromethylbenzimidazoly]-N'-[2-bromophenyl] urea

a) Preparation of 4-nitro-2-trifluoromethylbenzimidazole

To a solution of 3-nitro-phenylenediamine(1.0g, 6.53 mmol) was added trifluoroacetic anhydride(1.37g, 6.53mmol). The mixture was then stirred for 1 hr. The solvents were then evaporated and the product was refluxed in toluene for 2 hrs. The solvents were then evaporated and the desired product was obtained (1.43g, 95%). ¹H NMR (CD₃SO₂CD₃): δ 9.40 (s, 1H), 8.31 (d, 1H), 8.39 (d, 1H), 7.58 (t, 1H).

b) Preparation of 4-amino-2-trifluoromethylbenzimidazole

To a solution of 4-nitro-2-trifluoromethylbenzimidazole (700mg, 3.0mmol) in methanol(50ml)and was added 10% Pd/C (200mg). The mixture was flushed with argon, then

hydrogen was bubbled through the solution for 10 min. and a hydrogen atmosphere was maintained at balloon pressure overnight. The mixture was filtered through celite and the celite was washed with methanol. The solvent was evaporated and chromatography of the resulting solid on silica gel (10%MeOH/ CH₂Cl₂) gave the desired product(560mg, 93 %). ¹H NMR (CD₃SO₂CD₃): δ 10.49 (s, 1H), 7.09 (t, 1H), 6.72 (d, 1H), 6.30 (d, 1H), 5.52 (bs, 2H).

5 c) Preparation of N-7-[2-trifluoromethyl benzimidazolyl]-N'-[2-bromophenyl] urea

N-7-[2-trifluoromethyl benzimidazolyl]-N'-[2-bromophenyl] urea was prepared from 4-amino-2-trifluoromethylbenzimidazole (360mg, 1.79 mmol) according to the procedure in General Method B. The product was purified by chromatography of the resulting solid on silica gel(EtOAc/ hexane(1equiv./1equiv.)). (35mg, 63%). ¹H NMR (CD₃SO₂CD₃): δ 9.94 (s, 1H), 9.89 (s, 1H), 9.02 (s, 1H), 8.09 (d, 1H), 8.00 (d, 1H), 7.61 (d, 1H), 7.32 (m, 2H), 7.20 (d, 1H), 7.00 (t, 1H).

10 Example 6

Preparation of N-(4-Cyano-1H-benzotriazol-7-yl)-N'-(2,3-dichlorophenyl) urea

15 a) Preparation of 2-cyano-5-nitroaniline

To a solution of 2-bromo-5-nitroaniline (5.0g, 23 mmol) in dimethylforamide (100ml) and pyridine (20ml) was stirred with copper(I) cyanide (2.05g,64 mmol). The mixture was then heated to 160° C for 48 hrs. The reaction was then cooled to room temperature and filtered through celite, the celite was washed with ethyl acetate. The solvent was evaporated and chromatography of the resulting solid on silica gel (25%EtOAc/ Hexane) gave the desired product (2.64 g, 70 %). ¹H NMR (CD₃COCD₃): δ 7.75 (s, 1H), 7.70 (d, 1H), 7.44 (dd, 1H), 6.25(bs, 2H).

20 b) Preparation of 2-cyano-5-nitro-phenylenediamine

To a solution of 2-cyano-5-nitroaniline (435 mg, 2.67mmol) in dimethylsulfoxide (25ml) was added tetramethylhydrazine iodide (534 mg, 2.67mmol) and sodium t-pentoxide (880 mg, 8.01mmol). The mixture was stirred at room temperature for 12 hrs., the reaction was quenched with 10% HCl. Precipitated solids were filtered and the remaining solution was extracted with ethyl acetate, the solvent was evaporated and chromatography of the resulting solid on silica gel (25%EtOAc/ Hexane) gave the desired product (254 mg, 53 %). ¹H NMR (CD₃COCD₃): δ 7.49 (d, 1H), 7.03 (bs, 2H), 6.80 (d, 1H), 5.78(bs, 2H).

25 c) Preparation of 4-cyano-7-nitrobenzotriazole

To a solution of 2-cyano-5-nitro-phenylenediamine (120 mg, 0.67 mmol) in acetic acid (20ml) was stirred with sodium nitrite (50 mg, 0.72 mmol). The mixture was then heated to 60° C for 1 hr. The reaction was then cooled to room temperature and the solvents were evaporated and chromatography of the resulting solid on silica gel (50%EtOAc/ Hexane) gave the desired product (120 mg, 95 %). ¹H NMR (CD₃COCD₃): δ 8.70 (d, 1H), 8.25 (d, 1H).

30 d) Preparation of 4-cyano-7-aminobenzotriazole

To a solution of 4-cyano-7-nitrobenzotriazole (120 mg, 0.63mmol) in methanol (250ml) was added 10% Pd/C (1.0g). The mixture was flushed with argon, then hydrogen was

bubbled through the solution for 10 min. and a hydrogen atmosphere was maintained at balloon pressure for 4 hrs. The reaction mixture was flushed with argon and 10% Pd/C (1.0g) was additionally added and a hydrogen atmosphere was maintained at balloon pressure for 1 hr. The mixture was filtered through celite and the celite was washed with methanol. The solvent was evaporated and chromatography of the resulting solid on silica gel (5%MeOH/ CH₂Cl₂) gave the desired product (95 mg, 94 %). ¹H NMR (CD₃OD): δ 7.58 (d, 1H), 6.53 (d, 1H).

5 e) Preparation of N-[5-cyano-2-benzotriazole]-N'-[2,3-dichlorophenyl] urea

N-[5-cyano-2-benzotriazole]-N'-[2,3-dichlorophenyl] urea was prepared from 7-amino-4-cyanobenzotriazole (95mg, 0.60 mmol) according to the procedure in General Method B. The product was purified by chromatography of the resulting solid on silica gel (EtOAc/ hexane(2equiv./3equiv.)). (410mg, 68%). ¹H NMR (CD₃COCD₃): δ 10.85 (s, 1H), 9.40 (s, 1H), 8.34 (d, 1H), 8.20 (d, 1H), 7.94 (d, 1H), 7.36 (d, 1H), 7.31 (t, 1H).

Example 7

15 15 Preparation of N-(2-Bromophenyl)-N'-(4-cyano-1H-benzotriazol-7-yl) urea

To a solution of 2-bromo-5-nitroaniline (5.0g, 23 mmol) in dimethylformamide (100ml) and pyridine (20ml) was stirred with copper (I) cyanide (2.05g, 64 mmol). The mixture was then heated to 160° C for 48 hrs. The reaction was then cooled to room temperature and filtered through celite, the celite was washed with ethyl acetate. The solvent was evaporated and chromatography of the resulting solid on silica gel (25%EtOAc/ Hexane) gave the desired product (2.64 g, 70 %). ¹H NMR (CD₃COCD₃): δ 7.75 (s, 1H), 7.70 (d, 1H), 7.44 (dd, 1H), 6.25(bs, 2H).

b) Preparation of 2-cyano-5-nitro-phenylenediamine

To a solution of 2-cyano-5-nitroaniline (435 mg, 2.67mmol) in dimethylsulfoxide (25ml) was added tetramethylhydrazine iodide (534 mg, 2.67mmol) and sodium t-pentoxide (880 mg, 8.01mmol). The mixture was stirred at room temperature for 12 hrs., the reaction was quenched with 10% HCl. Precipitated solids were filtered and the remaining solution was extracted with ethyl acetate, the solvent was evaporated and chromatography of the resulting solid on silica gel(25%EtOAc/ Hexane) gave the desired product (254 mg, 53 %). ¹H NMR (CD₃COCD₃): δ 7.49 (d, 1H), 7.03 (bs, 2H), 6.80 (d, 1H), 5.78(bs, 2H).

c) Preparation of 4-cyano-7-nitrobenzotriazole

To a solution of 2-cyano-5-nitro-phenylenediamine (120 mg, 0.67 mmol) in acetic acid (20ml) was stirred with sodium nitrite (50 mg, 0.72 mmol). The mixture was then heated to 60° C for 1 hr. The reaction was then cooled to room temperature and the solvents were evaporated and chromatography of the resulting solid on silica gel (50%EtOAc/ Hexane) gave the desired product (120 mg, 95 %). ¹H NMR (CD₃COCD₃): δ 8.70 (d, 1H), 8.25 (d, 1H).

d) Preparation of 4-cyano-7-aminobenzotriazole

To a solution of 4-cyano-7-nitrobenzotriazole (120 mg, 0.63mmol) in methanol (250ml) was added 10% Pd/C (1.0g). The mixture was flushed with argon, then hydrogen was

bubbled through the solution for 10 min. and a hydrogen atmosphere was maintained at balloon pressure for 4 hrs. The reaction mixture was flushed with argon and 10% Pd/C (1.0g) was additionally added and a hydrogen atmosphere was maintained at balloon pressure for 1 hr. The mixture was filtered through celite and the celite was washed with methanol. The solvent was evaporated and chromatography of the resulting solid on silica gel (5%MeOH/CH₂Cl₂) gave the desired product (95 mg, 94 %). ¹H NMR (CD₃OD): δ 7.58 (d, 1H), 6.53 (d, 1H).

5 e) Preparation of N-[4-cyano-[1,4]-benzotriazol-7yl]-N'-[2-bromophenyl] urea

N-[5-cyano-2-benzotriazole]-N'-[2-bromophenyl] urea was prepared from 7-amino-4-10 cyanobenzotriazole (95mg, 0.60 mmol) according to the procedure in General Method B. The product was purified by chromatography of the resulting solid on silica gel(EtOAc/hexane(2equiv./3equiv.)). (410mg, 68%). ¹H NMR (CD₃SO₂CD₃): δ 10.83 (s, 1H), 9.18 (s, 1H), 8.20 (d, 1H), 8.05 (d, 1H), 7.99 (d, 1H), 7.66 (d, 1H), 7.40 (t, 1H), 7.06 (t, 1H).

15 Using the analogous procedures to those indicated above or in the schematics, the following compounds may be synthesized:

Example 8: N-(2H,4H-3,2,4-benzothiazole 3,3-dioxide)-N'-(2-bromophenyl) urea ¹H NMR (DMSO-d₆) δ 10.96(s, 1H), 10.32(s, 1H), 9.05(s, 1H), 8.49(s, 1H), 8.08(d, 1H, J=11.50Hz), 20 7.63(d, 1H, J=11.50Hz), 7.35(t, 1H), 7.18(d, 1H, J=11.50), 7.01(t, 1H), 6.91(t, 1H), 6.60(d, 1H, J=11.50)

Example 9: N-(5-cyano-4-N-methyl-benzimidazolin-3-thione)-N'-(2,3-dichloro-phenyl) urea ¹H NMR (DMSO-d₆) δ 11.20(s, 1H), 9.52(s, 1H), 8.62(s, 1H), 8.15(m,2H), 7.61(d, 1H, J=13.25Hz), 25 7.45(d, 1H, J=13.25Hz), 7.37(m, 2H), 3.94(d, 3H)

Example 10: N-(5-cyano-benzimidazolin-3-thione)-N'-(2 bromophenyl) urea ¹H NMR (DMSO-d₆) δ 11.57(s, 1H), 10.43(s, 1H), 9.51(s, 1H), 8.31(s, 1H), 8.09(d, 1H, J=13.25Hz), 30 7.68(d, 1H, J=13.25Hz), 7.54(d, 1H, J=13.25), 7.44-7.36(m, 2H), 7.07(t, 1H)

Example 11: N-(5-cyano-4-N-methyl-benzimidazolin-3-thione)-N'-(2 bromophenyl) urea ¹H NMR (DMSO-d₆) δ 11.25(s, 1H), 9.51(s, 1H), 8.31(s, 1H), 8.09(d, 1H, J=13.25), 7.67(d, 1H, J=13.25Hz), 7.61(d, 1H, J=13.25Hz), 7.50(d, 1H, J=13.25), 7.39(t, 1H), 7.06(t, 1H), 3.94(s, 3H)

Example 12: N-(4-Cyano-2-oxo-3-methylbenzimidazol-7-yl)-N'-(2,3-dichlorophenyl) urea ¹H NMR (DMSO-d₆) δ 10.94(s, 1H), 9.46(s, 1H), 8.65(s, 1H), 8.18(m, 1H), 7.40-7.31(m, 3H), 35 7.26(d, 1H, J=13.25Hz), 3.55(s, 3H)

Example 13: N-(4-Cyano-2-oxo-2,3-dihydrobenzimidazol-7-yl)-N'-(2-bromo-phenyl)urea ^1H NMR (DMSO-d₆) δ 11.86(s, 1H), 10.82(s, 1H), 9.94(s, 1H), 8.70(s, 1H), 8.65(d, 1H, J=13.25Hz), 8.11(d, 1H, J=13.25Hz), 7.85(t, 1H), 7.76(m, 2H), 7.50(t, 1H)

5 Example 14: N-(4-Cyano-2-trifluoromethyl-7-benzimidazolyl)-N'-(2-bromophenyl) urea ^1H NMR (DMSO-d₆) δ 10.30(s, 1H), 9.25(s, 1H), 8.24(s, 1H), 7.96(m, 2H), 7.85(d, 1H, J=13.25Hz), 7.66(d, 1H, J=13.25Hz), 7.49(t, 1H), 7.07(t, 1H)

10 Example 15: N-(4-Cyano-7-benzimidazolyl)-N'-(2,3-dichlorophenyl) urea ^1H NMR (DMSO-d₆) δ 10.45(s, 1H), 10.34(s, 1H), 9.48(s, 1H), 8.44(s, 1H), 8.15(m, 2H), 7.68(d, 1H, J=13.25Hz), 7.85(t, 1H), 7.37(m, 2H)

15 Example 16: N-(4-Cyano-7-benzimidazolyl)-N'-(2-bromophenyl) urea ^1H NMR (Acetone-d₆) δ 11.81(s, 1H), 9.45(s, 1H), 8.84(s, 1H), 8.34(s, 1H), 8.26(m, 2H), 7.65(d, 2H), 7.41(t, 1H), 7.06(t, 1H)

20 Example 17: N-(5-cyano-benzimidazolin-3-thione)-N'-(2,3-dichlorophenyl) urea ^1H NMR (DMSO-d₆) δ 11.54(s, 1H), 10.42(s, 1H), 9.52(s, 1H), 8.62(s, 1H), 8.15(m, 1H), 7.54(d, 1H, J=13.25Hz), 7.40-7.30(t, m, 3H)

25 Example 18: N-(5-cyano-N-cyano-2-guanidine)-N'-(2-bromophenyl) urea ^1H NMR (DMSO-d₆) δ 10.89(s, 1H), 11.02(s, 1H), 9.66(s, 1H), 8.42(s, 1H), 8.04(d, 1H, J=13.25Hz), 7.66(d, 1H, J=13.25Hz), 7.50(m, 1H), 7.40(t, 1H), 7.06(t, 1H)

30 Example 19: N-(4-Cyano-2-oxo-3-methylbenzimidazol-7-yl)-N'-(2-bromophenyl) urea, alternatively called: N-4-(7-Cyano-1-methylbenzimidazolin-2-one)-N'-(2-bromophenyl) urea ^1H NMR (DMSO-d₆) δ 10.89(s, 1H), 9.39(s, 1H), 8.30(s, 1H), 8.10(d, 1H, J=13.25), 7.76(d, 1H, J=13.25Hz), 7.45-7.32(m, 2H), 7.26(d, 1H, J=13.25), 7.03 (t, 1H), 3.57 (s, 3H).

METHOD OF TREATMENT

The compounds of Formula (I) and/or Formula (II), or pharmaceutically acceptable salts thereof, can be used in the manufacture of a medicament for the prophylactic or therapeutic treatment of any disease state in a human, or other mammal, which is exacerbated or caused by excessive or unregulated IL-8 cytokine production by such mammal's cell, such as but not limited to monocytes and/or macrophages, or other chemokines which bind to the IL-8 α or β receptor, also referred to as the type I or type II receptor.

For purposes herein, the term "compounds of Formula (I)", or "Formula (I)" will also refer to "compounds of Formula (II)" or "Formula (II)" unless otherwise indicated.

Accordingly, the present invention provides a method of treating a chemokine mediated disease, wherein the chemokine is one which binds to an IL-8 α or β receptor and which method comprises administering an effective amount of a compound of Formula (I) or a pharmaceutically acceptable salt thereof. In particular, the chemokines are IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78.

The compounds of Formula (I) are administered in an amount sufficient to inhibit cytokine function, in particular IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78, such that they are biologically regulated down to normal levels of physiological function, or in some case to subnormal levels, so as to ameliorate the disease state. Abnormal levels of IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78 for instance in the context of the present invention, constitute: (i) levels of free IL-8 greater than or equal to 1 picogram per mL; (ii) any cell associated IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78 above normal physiological levels; or (iii) the presence of IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78 above basal levels in cells or tissues in which IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78 respectively, is produced.

There are many disease states in which excessive or unregulated IL-8 production is implicated in exacerbating and/or causing the disease. Chemokine mediated diseases include psoriasis, atopic dermatitis, arthritis, asthma, chronic obstructive pulmonary disease, adult respiratory distress syndrome, inflammatory bowel disease, Crohn's disease, ulcerative colitis, stroke, septic shock, endotoxic shock, gram negative sepsis, toxic shock syndrome, cardiac and renal reperfusion injury, glomerulonephritis, thrombosis, graft vs. host reaction, alzheimers disease, allograft rejections, malaria, restinosis, angiogenesis, atherosclerosis, osteoporosis, gingivitis, undesired hematopoietic stem cells release and diseases caused by respiratory viruses, including but not limited to rhinovirus and influenza virus, herpesviruses, including but not limited to herpes simplex I and II, and hepatitis viruses, including but not limited to Hepatitis B and Hepatitis C virus.

The association of interleukin-8 and rhinovirus may be found in articles such as: Turner, et al., Clin. Infect. Dis. (1998), 26(4), 840-846; Sanders, et al., J. Virol. (1998), 72(2), 934-942; Sethi, et al., Clin. Exp. Immunol. (1997), 110(3), 362-369; Zhu, et al., Am. J. Physiol. (1997), 273(4, Pt. 1), L814-L824; Terajima, et al., Am. J. Physiol. (1997), 273(4, Pt. 1), L749-L759; Grunberg, et al., Clin. Exp. Allergy (1997), 27(1), 36-45; and Johnston, et al., J. Infect. Dis. (1997), 175(2), 323-329.

The association of interleukin-8 and osteoporosis may be found in articles such as: Streckfus et al., J. Gerontol., Ser. A (1997), 52A(6), M343-M351; Hermann, T. WO 95/31722; and Chaudhary, et al., Endocrinology (Baltimore) (1992), 130(5), 2528-34.

These diseases are primarily characterized by massive neutrophil infiltration, T-cell infiltration, or neovascular growth, and are associated with increased IL-8, GRO α , GRO β , GRO γ or NAP-2 production which is responsible for the chemotaxis of neutrophils into the inflammatory site or the directional growth of endothelial cells. In contrast to other

inflammatory cytokines (IL-1, TNF, and IL-6), IL-8, GRO α , GRO β , GRO γ or NAP-2 has the unique property of promoting neutrophil chemotaxis, enzyme release including but not limited to elastase release as well as superoxide production and activation. The a-chemokines but particularly GRO α , GRO β , GRO γ or NAP-2, working through the IL-8 type I or II receptor can promote the neovascularization of tumors by promoting the directional growth of endothelial cells. Therefore, the inhibition of IL-8 induced chemotaxis or activation would lead to a direct reduction in the neutrophil infiltration.

Recent evidence also implicates the role of chemokines in the treatment of HIV infections, Littleman et al., Nature 381, pp661 (1996) and Koup et al., Nature 381, pp 667 (1996).

The present invention also provides for a means of treating, in an acute setting, as well as preventing, in those individuals deemed susceptible to, CNS injuries by the chemokine receptor antagonist compounds of Formula (I).

CNS injuries as defined herein include both open or penetrating head trauma, such as by surgery, or a closed head trauma injury, such as by an injury to the head region. Also included within this definition is ischemic stroke, particularly to the brain area.

Ischemic stroke may be defined as a focal neurologic disorder that results from insufficient blood supply to a particular brain area, usually as a consequence of an embolus, thrombi, or local atheromatous closure of the blood vessel. The role of inflammatory cytokines in this area has been emerging and the present invention provides a mean for the potential treatment of these injuries. Relatively little treatment, for an acute injury such as these has been available.

TNF- α is a cytokine with proinflammatory actions, including endothelial leukocyte adhesion molecule expression. Leukocytes infiltrate into ischemic brain lesions and hence compounds which inhibit or decrease levels of TNF would be useful for treatment of ischemic brain injury. See Liu et al., Stoke, Vol. 25., No. 7, pp 1481-88 (1994) whose disclosure is incorporated herein by reference.

Models of closed head injuries and treatment with mixed 5-LO/CO agents is discussed in Shohami et al., J. of Vaisc & Clinical Physiology and Pharmacology, Vol. 3, No. 2, pp. 99-107 (1992) whose disclosure is incorporated herein by reference. Treatment which reduced edema formation was found to improve functional outcome in those animals treated.

Present evidence also indicates the use of IL-8 inhibitors in the treatment of atherosclerosis. The first reference, Boisvert et al., J Clin Invest, 1998, 101:353-363 shows, through bone marrow transplantation, that the absence of IL-8 receptors on stem cells (and, therefore, on monocytes/macrophages) leads to a reduction in the development of atherosclerotic plaques in LDL receptor deficient mice. Additional supporting references are: Apostolopoulos, et al., Arterioscler Thromb Vasc Biol. 1996, 16:1007-1012; Liu, et al., Arterioscler Thromb Vasc Biol, 1997, 17:317-323; Rus, et al., Atherosclerosis. 1996, 127:263-271.; Wang et al., J Biol Chem. 1996, 271:8837-8842; Yue, et al., Eur J Pharmacol. 1993,

240:81-84; Koch, et al., Am J Pathol, 1993, 142:1423-1431.; Lee, et al., Immunol Lett, 1996,
53, 109-113.; and
Terkeltaub et al., Arterioscler Thromb, 1994, 14:47-53.

The compounds of Formula (I) are administered in an amount sufficient to inhibit
5 IL-8, binding to the IL-8 alpha or beta receptors, from binding to these receptors, such as evidenced by a reduction in neutrophil chemotaxis and activation. The discovery that the compounds of Formula (I) are inhibitors of IL-8 binding is based upon the effects of the compounds of Formulas (I) in the in vitro receptor binding assays which are described herein. The compounds of Formula (I) have been shown to be inhibitors of type II IL-8 receptors.

10 As used herein, the term "IL-8 mediated disease or disease state" refers to any and all disease states in which IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78 plays a role, either by production of IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78 themselves, or by IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78 causing another monokine to be released, such as but not limited to IL-1, IL-6 or TNF. A disease state in which, for instance, IL-1 is a major component, and whose production or action, is exacerbated or secreted in response to IL-8, would therefore be considered a disease state mediated by IL-8.

15 As used herein, the term "chemokine mediated disease or disease state" refers to any and all disease states in which a chemokine which binds to an IL-8 α or β receptor plays a role, such as but not limited to IL-8, GRO α , GRO β , GRO γ , NAP-2, or ENA-78. This would include a disease state in which, IL-8 plays a role, either by production of IL-8 itself, or by IL-8 causing another monokine to be released, such as but not limited to IL-1, IL-6 or TNF. A disease state in which, for instance, IL-1 is a major component, and whose production or action, is exacerbated or secreted in response to IL-8, would therefore be considered a disease state mediated by IL-8.

20 25 As used herein, the term "cytokine" refers to any secreted polypeptide that affects the functions of cells and is a molecule which modulates interactions between cells in the immune, inflammatory or hematopoietic response. A cytokine includes, but is not limited to, monokines and lymphokines, regardless of which cells produce them. For instance, a monokine is generally referred to as being produced and secreted by a mononuclear cell, such as a macrophage and/or monocyte. Many other cells however also produce monokines, such as natural killer cells, fibroblasts, basophils, neutrophils, endothelial cells, brain astrocytes, bone marrow stromal cells, epidermal keratinocytes and B-lymphocytes. Lymphokines are generally referred to as being produced by lymphocyte cells. Examples of cytokines include, but are not limited to, Interleukin-1 (IL-1), Interleukin-6 (IL-6), Interleukin-8 (IL-8), Tumor Necrosis Factor-alpha (TNF- α) and Tumor Necrosis Factor beta (TNF- β).

30 35 As used herein, the term "chemokine" refers to any secreted polypeptide that affects the functions of cells and is a molecule which modulates interactions between cells in the immune, inflammatory or hematopoietic response, similar to the term "cytokine" above. A chemokine is primarily secreted through cell transmembranes and causes chemotaxis and

activation of specific white blood cells and leukocytes, neutrophils, monocytes, macrophages, T-cells, B-cells, endothelial cells and smooth muscle cells. Examples of chemokines include, but are not limited to, IL-8, GRO α , GRO β , GRO γ , NAP-2, ENA-78, IP-10, MIP-1 α , MIP- β , PF4, and MCP 1, 2, and 3.

5 In order to use a compound of Formula (I) or a pharmaceutically acceptable salt thereof in therapy, it will normally be formulated into a pharmaceutical composition in accordance with standard pharmaceutical practice. This invention, therefore, also relates to a pharmaceutical composition comprising an effective, non-toxic amount of a compound of Formula (I) and a pharmaceutically acceptable carrier or diluent.

10 Compounds of Formula (I), pharmaceutically acceptable salts thereof and pharmaceutical compositions incorporating such may conveniently be administered by any of the routes conventionally used for drug administration, for instance, orally, topically, parenterally or by inhalation. The compounds of Formula (I) may be administered in conventional dosage forms prepared by combining a compound of Formula (I) with standard 15 pharmaceutical carriers according to conventional procedures. The compounds of Formula (I) may also be administered in conventional dosages in combination with a known, second therapeutically active compound. These procedures may involve mixing, granulating and compressing or dissolving the ingredients as appropriate to the desired preparation. It will be appreciated that the form and character of the pharmaceutically acceptable character or diluent 20 is dictated by the amount of active ingredient with which it is to be combined, the route of administration and other well-known variables. The carrier(s) must be "acceptable" in the sense of being compatible with the other ingredients of the formulation and not deleterious to the recipient thereof.

The pharmaceutical carrier employed may be, for example, either a solid or liquid. 25 Exemplary of solid carriers are lactose, terra alba, sucrose, talc, gelatin, agar, pectin, acacia, magnesium stearate, stearic acid and the like. Exemplary of liquid carriers are syrup, peanut oil, olive oil, water and the like. Similarly, the carrier or diluent may include time delay material well known to the art, such as glyceryl mono-stearate or glyceryl distearate alone or with a wax.

30 A wide variety of pharmaceutical forms can be employed. Thus, if a solid carrier is used, the preparation can be tableted, placed in a hard gelatin capsule in powder or pellet form or in the form of a troche or lozenge. The amount of solid carrier will vary widely but preferably will be from about 25mg. to about 1g. When a liquid carrier is used, the preparation will be in the form of a syrup, emulsion, soft gelatin capsule, sterile injectable liquid such as an 35 ampule or nonaqueous liquid suspension.

Compounds of Formula (I) may be administered topically, that is by non-systemic administration. This includes the application of a compound of Formula (I) externally to the epidermis or the buccal cavity and the instillation of such a compound into the ear, eye and nose, such that the compound does not significantly enter the blood stream. In contrast,

systemic administration refers to oral, intravenous, intraperitoneal and intramuscular administration.

Formulations suitable for topical administration include liquid or semi-liquid preparations suitable for penetration through the skin to the site of inflammation such as liniments, lotions, creams, ointments or pastes, and drops suitable for administration to the eye, ear or nose. The active ingredient may comprise, for topical administration, from 0.001% to 10% w/w, for instance from 1% to 2% by weight of the formulation. It may however comprise as much as 10% w/w but preferably will comprise less than 5% w/w, more preferably from 0.1% to 1% w/w of the formulation.

Lotions according to the present invention include those suitable for application to the skin or eye. An eye lotion may comprise a sterile aqueous solution optionally containing a bactericide and may be prepared by methods similar to those for the preparation of drops. Lotions or liniments for application to the skin may also include an agent to hasten drying and to cool the skin, such as an alcohol or acetone, and/or a moisturizer such as glycerol or an oil such as castor oil or arachis oil.

Creams, ointments or pastes according to the present invention are semi-solid formulations of the active ingredient for external application. They may be made by mixing the active ingredient in finely-divided or powdered form, alone or in solution or suspension in an aqueous or non-aqueous fluid, with the aid of suitable machinery, with a greasy or non-greasy base. The base may comprise hydrocarbons such as hard, soft or liquid paraffin, glycerol, beeswax, a metallic soap; a mucilage; an oil of natural origin such as almond, corn, arachis, castor or olive oil; wool fat or its derivatives or a fatty acid such as steric or oleic acid together with an alcohol such as propylene glycol or a macrogel. The formulation may incorporate any suitable surface active agent such as an anionic, cationic or non-ionic surfactant such as a sorbitan ester or a polyoxyethylene derivative thereof. Suspending agents such as natural gums, cellulose derivatives or inorganic materials such as siliceous silicas, and other ingredients such as lanolin, may also be included.

Drops according to the present invention may comprise sterile aqueous or oily solutions or suspensions and may be prepared by dissolving the active ingredient in a suitable aqueous solution of a bactericidal and/or fungicidal agent and/or any other suitable preservative, and preferably including a surface active agent. The resulting solution may then be clarified by filtration, transferred to a suitable container which is then sealed and sterilized by autoclaving or maintaining at 98-100 °C. for half an hour. Alternatively, the solution may be sterilized by filtration and transferred to the container by an aseptic technique. Examples of bactericidal and fungicidal agents suitable for inclusion in the drops are phenylmercuric nitrate or acetate (0.002%), benzalkonium chloride (0.01%) and chlorhexidine acetate (0.01%). Suitable solvents for the preparation of an oily solution include glycerol, diluted alcohol and propylene glycol.

Compounds of formula (I) may be administered parenterally, that is by intravenous, intramuscular, subcutaneous intranasal, intrarectal, intravaginal or intraperitoneal administration. The subcutaneous and intramuscular forms of parenteral administration are generally preferred. Appropriate dosage forms for such administration may be prepared by conventional techniques. Compounds of Formula (I) may also be administered by inhalation, that is by intranasal and oral inhalation administration. Appropriate dosage forms for such administration, such as an aerosol formulation or a metered dose inhaler, may be prepared by conventional techniques.

For all methods of use disclosed herein for the compounds of Formula (I), the daily oral dosage regimen will preferably be from about 0.01 to about 80 mg/kg of total body weight. The daily parenteral dosage regimen about 0.001 to about 80 mg/kg of total body weight. The daily topical dosage regimen will preferably be from 0.1 mg to 150 mg, administered one to four, preferably two or three times daily. The daily inhalation dosage regimen will preferably be from about 0.01 mg/kg to about 1 mg/kg per day. It will also be recognized by one of skill in the art that the optimal quantity and spacing of individual dosages of a compound of Formula (I) or a pharmaceutically acceptable salt thereof will be determined by the nature and extent of the condition being treated, the form, route and site of administration, and the particular patient being treated, and that such optimums can be determined by conventional techniques. It will also be appreciated by one of skill in the art that the optimal course of treatment, i.e., the number of doses of a compound of Formula (I) or a pharmaceutically acceptable salt thereof given per day for a defined number of days, can be ascertained by those skilled in the art using conventional course of treatment determination tests.

The invention will now be described by reference to the following biological examples which are merely illustrative and are not to be construed as a limitation of the scope of the present invention.

BIOLOGICAL EXAMPLES

The IL-8, and Gro- α chemokine inhibitory effects of compounds of the present invention are determined by the following in vitro assay:

30 Receptor Binding Assays:

[¹²⁵I] IL-8 (human recombinant) is obtained from Amersham Corp., Arlington Heights, IL, with specific activity 2000 Ci/mmol. Gro-a is obtained from NEN- New England Nuclear. All other chemicals are of analytical grade. High levels of recombinant human IL-8 type a and b receptors were individually expressed in Chinese hamster ovary cells as described previously (Holmes, et al., Science, 1991, 253, 1278). The Chinese hamster ovary membranes were homogenized according to a previously described protocol (Haour, et al., J Biol Chem., 249 pp 2195-2205 (1974)). Except that the homogenization buffer is changed to 10mM Tris-HCL, 1mM MgSO₄, 0.5mM EDTA (ethylene-diaminetetra-acetic acid), 1m MPMSF (a-

toluenesulphonyl fluoride), 0.5 mg/L Leupeptin, pH 7.5. Membrane protein concentration is determined using Pierce Co. micro-assay kit using bovine serum albumin as a standard. All assays are performed in a 96-well micro plate format. Each reaction mixture contains ^{125}I IL-8 (0.25 nM) or ^{125}I Gro-a and 0.5 $\mu\text{g}/\text{mL}$ of IL-8Ra or 1.0 $\mu\text{g}/\text{mL}$ of IL-8Rb membranes in 20 mM Bis-Trispropane and 0.4 mM Tris HCl buffers, pH 8.0, containing 1.2 mM MgSO₄, 0.1 mM EDTA, 25 mM NaCl and 0.03% CHAPS. In addition, drug or compound of interest is added which has been pre-dissolved in DMSO so as to reach a final concentration of between 0.01nM and 100 uM. The assay is initiated by addition of ^{125}I -IL-8. After 1 hour at room temperature the plate is harvested using a Tomtec 96-well harvester onto a glass fiber filtermat 5 blocked with 1% polyethylenimine/ 0.5% BSA and washed 3 times with 25 mM NaCl, 10 mM TrisHCl, 1 mM MgSO₄, 0.5 mM EDTA, 0.03 % CHAPS, pH 7.4. The filter is then dried and counted on the Betaplate liquid scintillation counter. The recombinant IL-8 Ra, or Type I, receptor is also referred to herein as the non-permissive receptor and the recombinant IL-8 Rb, or Type II, receptor is referred to as the permissive receptor.

10 Representative compounds of Formula (I), and (II), Examples 1 to 11, and 13 to 19 herein demonstrated positive inhibitory activity of < 30 μmg in this assay. For The compound of Example 12 did not demonstrate activity at <30 μmg in this assay, likely due to solubility issues.

15 **Chemotaxis Assay :**
20 The in vitro inhibitory properties of these compounds are determined in the neutrophil chemotaxis assay as described in Current Protocols in Immunology, vol. I, Suppl 1, Unit 6.12.3., whose disclosure is incorporated herein by reference in its entirety. Neutrophils where isolated from human blood as described in Current Protocols in Immunology Vol. I, Suppl 1 Unit 7.23.1, whose disclosure is incorporated herein by reference in its entirety. The
25 chemoattractants IL-8, GRO α , GRO β , GRO γ and NAP-2 are placed in the bottom chamber of a 48 multiwell chamber (Neuro Probe, Cabin John, MD) at a concentration between 0.1 and 100 nM. The two chambers are separated by a 5um polycarbonate filter. When compounds of this invention are tested, they are mixed with the cells (0.001 - 1000 nM) just prior to the addition of the cells to the upper chamber. Incubation is allowed to proceed for between about
30 45 and 90 min. at about 37°C in a humidified incubator with 5% CO₂. At the end of the incubation period, the polycarbonate membrane is removed and the top side washed, the membrane then stained using the Diff Quick staining protocol (Baxter Products, McGaw Park, IL, USA). Cells which have chemotaxed to the chemokine are visually counted using a microscope. Generally, four fields are counted for each sample, these numbers are averaged to give the average number of cells which had migrated. Each sample is tested in triplicate and each compound repeated at least four times. To certain cells (positive control cells) no compound is added, these cells represent the maximum chemotactic response of the cells. In the case where a negative control (unstimulated) is desired, no chemokine is added to the
35

bottom chamber. The difference between the positive control and the negative control represents the chemotactic activity of the cells.

Elastase Release Assay:

The compounds of this invention are tested for their ability to prevent Elastase release from human neutrophils. Neutrophils are isolated from human blood as described in Current Protocols in Immunology Vol. I, Suppl 1 Unit 7.23.1. PMNs 0.88×10^6 cells suspended in Ringer's Solution (NaCl 118, KCl 4.56, NaHCO₃ 25, KH₂PO₄ 1.03, Glucose 11.1, HEPES 5 mM, pH 7.4) are placed in each well of a 96 well plate in a volume of 50 μ l. To this plate is added the test compound (0.001 - 1000 nM) in a volume of 50 μ l, Cytochalasin B in a volume of 50 μ l (20ug/ml) and Ringers buffer in a volume of 50 μ l. These cells are allowed to warm (37 °C, 5% CO₂, 95% RH) for 5 min before IL-8, GRO α , GRO β , GRO γ or NAP-2 at a final concentration of 0.01 - 1000 nM was added. The reaction is allowed to proceed for 45 min. before the 96 well plate is centrifuged (800 xg 5 min.) and 100 μ l of the supernatant removed. This supernatant is added to a second 96 well plate followed by an artificial elastase substrate (MeOSuc-Ala-Ala-Pro-Val-AMC, Nova Biochem, La Jolla, CA) to a final concentration of 6 ug/ml dissolved in phosphate buffered saline. Immediately, the plate is placed in a fluorescent 96 well plate reader (Cytofluor 2350, Millipore, Bedford, MA) and data collected at 3 min. intervals according to the method of Nakajima et al J. Biol Chem 254 4027 (1979). The amount of Elastase released from the PMNs is calculated by measuring the rate of MeOSuc-Ala-Ala-Pro-Val-AMC degradation.

TNF- α in Traumatic Brain Injury Assay

This assay provides for examination of the expression of tumor necrosis factor mRNA in specific brain regions which follow experimentally induced lateral fluid-percussion traumatic brain injury (TBI) in rats. Since TNF- α is able to induce nerve growth factor (NGF) and stimulate the release of other cytokines from activated astrocytes, this post-traumatic alteration in gene expression of TNF- α plays an important role in both the acute and regenerative response to CNS trauma. A suitable assay may be found in WO 97/35856 or WO 97/49286 whose disclosures are incorporated herein by reference.

CNS Injury model for IL- β mRNA

This assay characterizes the regional expression of interleukin-1 β (IL-1 β) mRNA in specific brain regions following experimental lateral fluid-percussion traumatic brain injury (TBI) in rats. Results from these assays indicate that following TBI, the temporal expression of IL-1 β mRNA is regionally stimulated in specific brain regions. These regional changes in cytokines, such as IL-1 β play a role in the post-traumatic pathologic or regenerative sequelae of brain injury. A suitable assay may be found in WO 97/35856 or WO 97/49286 whose disclosures are incorporated herein by reference.

In vivo - atherosclerosis assay:

In vivo models for measuring atherosclerosis in mice is based on the assay of Paigen et al with small modifications as described below. See Paigen B, Morrow A, Holmes PA, Mitchell D,

Williams RA. Quantitative assessment of atherosclerotic lesions in mice. *Atherosclerosis* 68: 231-240 (1987); and Groot PHE, van Vlijmen BJM, Benson GM, Hofker MH, Schiffelers R, Vidgeon-Hart M, Havekes LM. Quantitative assessment of aortic atherosclerosis in APOE*3 Leiden transgenic mice and its relationship to serum cholesterol exposure. *Arterioscler Thromb Vasc Biol.* 16: 926-933 (1996).

5 Sectioning and staining of the aortic sinus

Cross-sections of the aortic root are taken as has been described previously (1,2). Briefly, the hearts are bisected just below the level of the atria and the base of the heart plus aortic root are taken for analysis. After equilibrating the tissue in OCT compound overnight the hearts are 10 immersed in OCT compound on a cryostat chuck (Bright Instrument Company Ltd., UK) with the aorta facing the chuck. The tissue is frozen by surrounding the chuck with dry ice. The hearts are then sectioned perpendicular to the axis of the aorta, starting within the heart and working in the direction of the aorta. Once the aortic root has been identified by the appearance of the three valve leaflets, alternate 10 mm sections are taken and mounted on gelatinised slides. Sections are air 15 dried for 1 hour and subsequently rinsed briefly in 60% isopropyl alcohol. The sections are stained with Oil Red O, counterstained with Mayer's haematoxylin, cover slipped using glycerol gelatine and sealed with nail varnish.

Quantification of atherosclerosis in the aortic root

Ten alternate sections of the aortic root are imaged using an Olympus BH-2 microscope equipped 20 with an 4x objective and a video camera (Hitachi, HV-C10). Twenty-four bit colour images are acquired and analysed using a PC (Datacell Pentium P5-133, Datacell, Berks, U.K.) fitted with a framegrabbing board (Snapper, Active Imaging Ltd, Berks, U.K.) and running Optimas software (version 5.1, Optimas Corp., WA, U.S.A.). The images are captured under identical lighting, microscope, camera and PC conditions. Quantification of the atherosclerotic lesion areas is 25 performed by drawing around the lesions by hand using the Optimas software. Colour thresholds are set that quantify the areas that are stained red within the lesions. Absolute values for the cross-sectional areas of the lesions and the areas stained red are obtained by calibrating the software using an image of the grid on a haemocytometer slide.

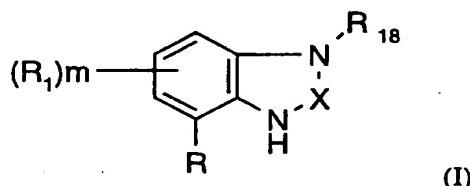
All publications, including but not limited to patents and patent applications, cited in this 30 specification are herein incorporated by reference as if each individual publication were specifically and individually indicated to be incorporated by reference herein as though fully set forth.

The above description fully discloses the invention including preferred embodiments thereof. Modifications and improvements of the embodiments specifically disclosed herein are 35 within the scope of the following claims. Without further elaboration, it is believed that one skilled in the art can, using the preceding description, utilize the present invention to its fullest extent. Therefore the Examples herein are to be construed as merely illustrative and not a limitation of the scope of the present invention in any way. The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

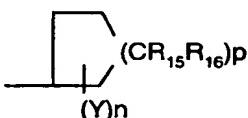
What is Claimed Is:

1. A method of treating a chemokine mediated disease in a mammal in need thereof, wherein the chemokine binds to an IL-8 α or β receptor, selected from the group consisting of malaria, restinosis, angiogenesis, atherosclerosis, osteoporosis, gingivitis, undesired hematopoietic stem cells release and diseases caused by respiratory viruses, herpesviruses, and hepatitis viruses, which method comprises administering to said mammal an effective amount of a compound according to the formula:

10



wherein

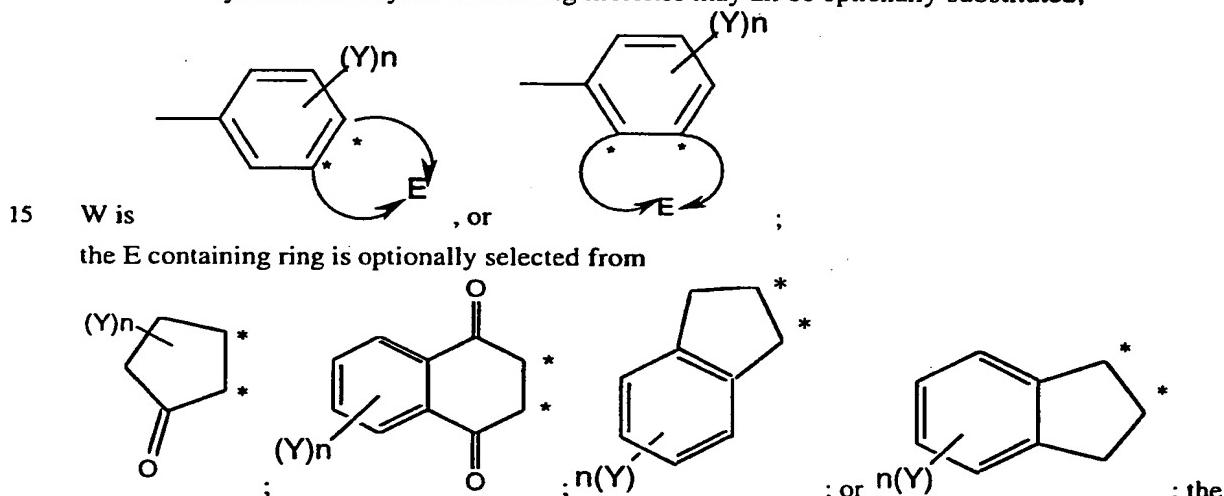
 R is $-\text{NH}-\text{C}(\text{X}_2)-\text{NH}- (\text{CR}_{13}\text{R}_{14})_v - \text{Z};$  Z is W , HET, --- , an optionally substituted C_{1-10} alkyl, an optionally substituted C_{2-10} alkenyl, or an optionally substituted C_{2-10} alkynyl; X is $\text{C}(\text{X}_1)_2$, $\text{C}(\text{O})$, $\text{C}(\text{S})$, $\text{S}(\text{O})_2$, $\text{PO}(\text{OR}_4)$, or $\text{C}=\text{N}-\text{R}_{19}$; X_1 is independently hydrogen, halogen, C_{1-10} alkyl, NR_4R_5 , C_{1-10} alkyl- NR_4R_5 , $\text{C}(\text{O})\text{NR}_4\text{R}_5$, optionally substituted C_{1-10} alkyl, C_{1-10} alkoxy, halosubstituted C_{1-10} alkoxy, hydroxy, aryl, aryl C_{1-4} alkyl, aryloxy, aryl C_{1-4} alkyloxy, heteroaryl,20 heteroarylalkyl, heterocyclic, heterocyclic C_{1-4} alkyl, or heteroaryl C_{1-4} alkyloxy; X_2 is $=\text{O}$, or $=\text{S}$; R_1 is independently selected from hydrogen; halogen; nitro; cyano; halosubstituted C_{1-10} alkyl; C_{1-10} alkyl; C_{2-10} alkenyl; C_{1-10} alkoxy; halosubstituted C_{1-10} alkoxy; azide; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{S}(\text{O})_2\text{R}_4$; hydroxy; hydroxy C_{1-4} alkyl; aryl; aryl C_{1-4} alkyl; aryloxy; aryl C_{1-4} alkyloxy; heteroaryl; heteroarylalkyl; heterocyclic; heterocyclic C_{1-4} alkyl; heteroaryl C_{1-4} alkyloxy; aryl C_{2-10} alkenyl; heteroaryl C_{2-10} alkenyl; heterocyclic C_{2-10} alkenyl;25 $(\text{CR}_8\text{R}_8)\text{q}\text{NR}_4\text{R}_5$; C_{2-10} alkenyl $\text{C}(\text{O})\text{NR}_4\text{R}_5$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{C}(\text{O})\text{NR}_4\text{R}_5$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{C}(\text{O})\text{NR}_4\text{R}_{10}$; $\text{S}(\text{O})_3\text{R}_8$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{C}(\text{O})\text{R}_{11}$; C_{2-10} alkenyl $\text{C}(\text{O})\text{R}_{11}$; C_{2-10} alkenyl $\text{C}(\text{O})\text{OR}_{11}$; $\text{C}(\text{O})\text{R}_{11}$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{C}(\text{O})\text{OR}_{12}$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{OC}(\text{O})\text{R}_{11}$;30 $(\text{CR}_8\text{R}_8)\text{q}\text{C}(\text{NR}_4)\text{NR}_4\text{R}_5$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{NR}_4\text{C}(\text{NR}_5)\text{R}_{11}$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{NR}_4\text{C}(\text{O})\text{R}_{11}$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{NHS}(\text{O})_2\text{R}_{17}$; $(\text{CR}_8\text{R}_8)\text{q}$ $\text{S}(\text{O})_2\text{NR}_4\text{R}_5$; or two R_1 moieties together may form $\text{O}-(\text{CH}_2)_n\text{O}$ or a 5 to 6 membered saturated or unsaturated ring; and wherein the aryl, heteroaryl, and heterocyclic containing moieties may all be optionally substituted;

- n is an integer having a value of 1 to 3;
m is an integer having a value of 1 to 3;
q is 0, or an integer having a value of 1 to 10;
s is an integer having a value of 1 to 3;
- 5 t is 0, or an integer having a value of 1 or 2;
v is 0, or an integer having a value of 1 to 4;
p is an integer having a value of 1 to 3;
HET is an optionally substituted heteroaryl;
R₄ and R₅ are independently hydrogen, optionally substituted C₁₋₄ alkyl, optionally
- 10 substituted aryl, optionally substituted aryl C₁₋₄alkyl, optionally substituted heteroaryl, optionally substituted heteroaryl C₁₋₄alkyl, heterocyclic, or heterocyclic C₁₋₄ alkyl, or R₄ and R₅ together with the nitrogen to which they are attached form a 5 to 7 member ring which may optionally comprise an additional heteroatom selected from O/N/S;
- Y is independently selected from hydrogen; halogen; nitro; cyano; halosubstituted C₁₋₁₀ alkyl;
- 15 C₁₋₁₀ alkyl; C₂₋₁₀ alkenyl; C₁₋₁₀ alkoxy; halosubstituted C₁₋₁₀ alkoxy; azide; (CR₈R₈)_qS(O)_tR₄; hydroxy; hydroxyC₁₋₄alkyl; aryl; aryl C₁₋₄ alkyl; aryloxy; arylC₁₋₄ alkyloxy; heteroaryl; heteroarylalkyl; heteroaryl C₁₋₄ alkyloxy; heterocyclic, heterocyclic C₁₋₄alkyl; aryl C₂₋₁₀ alkenyl; heteroaryl C₂₋₁₀ alkenyl; heterocyclic C₂₋₁₀ alkenyl; (CR₈R₈)_qNR₄R₅; C₂₋₁₀ alkenyl C(O)NR₄R₅; (CR₈R₈)_qC(O)NR₄R₅; (CR₈R₈)_q
- 20 C(O)NR₄R₁₀; S(O)₃R₈; (CR₈R₈)_qC(O)R₁₁; C₂₋₁₀ alkenyl C(O)R₁₁; C₂₋₁₀ alkenyl C(O)OR₁₁; (CR₈R₈)_qC(O)OR₁₂; (CR₈R₈)_qOC(O) R₁₁; (CR₈R₈)_qNR₄C(O)R₁₁; (CR₈R₈)_qC(NR₄)NR₄R₅; (CR₈R₈)_qNR₄C(NR₅)R₁₁; (CR₈R₈)_qNHS(O)₂R_a; (CR₈R₈)_qS(O)₂NR₄R₅; or two Y moieties together may form O-(CH₂)_sO or a 5 to 6 membered saturated or unsaturated ring; and wherein the aryl, heteroaryl, and heterocyclic containing moieties may all be optionally substituted;
- 25 R₆ and R₇ are independently hydrogen or a C₁₋₄ alkyl group, or R₆ and R₇ together with the nitrogen to which they are attached form a 5 to 7 member ring which ring may optionally contain an additional heteroatom which heteroatom is selected from oxygen, nitrogen or sulfur;
- 30 R₈ is independently hydrogen or C₁₋₄ alkyl;
R₁₀ is C₁₋₁₀ alkyl C(O)₂R₈;
R₁₁ is hydrogen, C₁₋₄ alkyl, optionally substituted aryl, optionally substituted aryl C₁₋₄alkyl, optionally substituted heteroaryl, optionally substituted heteroarylC₁₋₄alkyl, optionally substituted heterocyclic, or optionally substituted heterocyclicC₁₋₄alkyl;
- 35 R₁₂ is hydrogen, C₁₋₁₀ alkyl, optionally substituted aryl or optionally substituted arylalkyl;
R₁₃ and R₁₄ are independently hydrogen, optionally substituted C₁₋₄ alkyl, or one of R₁₃ and R₁₄ may be optionally substituted aryl;
R₁₅ and R₁₆ are independently hydrogen, or an optionally substituted C₁₋₄ alkyl;

R₁₇ is C₁₋₄alkyl, aryl, arylalkyl, heteroaryl, heteroarylC₁₋₄alkyl, heterocyclic, or heterocyclicC₁₋₄alkyl, wherein the aryl, heteroaryl and heterocyclic moieties may all be optionally substituted;

5 R₁₈ is hydrogen, optionally substituted C₁₋₁₀ alkyl, C₁₋₁₀ alkoxy, halosubstituted C₁₋₁₀ alkoxy, hydroxy, arylC₁₋₄ alkyl, arylC₂₋₄ alkenyl, heteroaryl, heteroaryl-C₁₋₄alkyl, heteroarylC₂₋₄ alkenyl, heterocyclic, or heterocyclicC₁₋₄ alkyl, wherein all the aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted;
R₁₉ is cyano, nitro, S(O)₂NR₄R₅, S(O)₂R₁₇, alkyl, arylC₁₋₄ alkyl, arylC₂₋₄ alkenyl,
10 heteroaryl, heteroaryl-C₁₋₄alkyl, heteroarylC₂₋₄ alkenyl, heterocyclic, or heterocyclicC₁₋₄ alkyl, wherein the alkyl, aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted;

R_a is NR₆R₇, alkyl, arylC₁₋₄ alkyl, arylC₂₋₄ alkenyl, heteroaryl, heteroaryl-C₁₋₄alkyl, heteroarylC₂₋₄ alkenyl, heterocyclic, or heterocyclicC₁₋₄ alkyl, wherein the aryl, heteroaryl and heterocyclic containing moieties may all be optionally substituted;



asterix * denoting point of attachment of the ring;
or a pharmaceutically acceptable salt thereof.

20 2. The method according to Claim 1 wherein R₁ is halogen, cyano, nitro, CF₃, C(O)NR₄R₅, alkenyl C(O)NR₄R₅, C(O) R₄R₁₀, alkenyl C(O)OR₁₂, heteroaryl, heteroarylalkyl, heteroaryl alkenyl, or S(O)NR₄R₅.

25 3. The method according to Claim 1 wherein X is C(O) or C(S).

4. The method according according to any of Claims 1 to 3 wherein Z is W.

5. The method according to Claim 4 wherein Y is halogen, C₁₋₄ alkoxy, 30 optionally substituted aryl, optionally substituted arylalkoxy, methylene dioxy, NR₄R₅.

thioC₁₋₄alkyl, thioaryl, halosubstituted alkoxy, optionally substituted C₁₋₄alkyl, or hydroxy alkyl.

6. The method according to Claim 1 wherein the compound is selected from the
5 group consisting of :

- N-4-(Benzimidazoline-2-one-N'-(2'-bromophenyl)urea;
- N-4-(1H,3H-2,1,3-benzothiazole 2,2-dioxide)-N'-(2-bromophenyl) urea;
- N-4-(7-Cyano-1-N-methyl-benzimidazoline-2-thione)-N'-(2,3-dichlorophenyl) urea;
- N-4-(7-Cyano-benzimidazoline-2-thione)-N'-(2 bromophenyl) urea;
- 10 N-4-(7-Cyano-1-methyl-benzimidazoline-2-thione)-N'-(2 bromophenyl) urea;
- N-(4-Cyano-2-oxo-3-methylbenzimidazol-7-yl)-N'-(2-bromophenyl) urea
- N-4-(7-Cyano-benzimidazoline-2-one)-N'-(2-bromophenyl)urea;
- N-4-(7-Cyano-benzimidazoline-2-thione)-N'-(2,3-dichlorophenyl) urea; and
- N-4-(7-Cyano benzimidazoline-2-imine)-N'-(2-bromophenyl) urea; or
- 15 a pharmaceutically acceptable salt thereof.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/16506

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61K 31/41

US CL : 414/361

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 414/361

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST 2.0

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,900,430 A (BADGER et al.) 04 May 1999 (04.05.99), see the entire document.	1-6

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	& document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

30 AUGUST 2000

Date of mailing of the international search report

12 OCT 2000

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